PRINCIPLES OF HUMAN GEOGRAPHY

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PRINCIPLES OF HUMAN GEOGRAPHY

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FIFTH EDITION LARGELY REWRITTEN

Based on Original Work in Collaboration with the late

SUMNER W. CUSHING

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PREFACE TO FIFTH EDITION

The purpose of this book, as stated in the Preface to the First Edition, is "to set forth the great principles of geography in its human aspects; to provide a comprehensive, but easily taught textbook for students who have reached an age when they begin to think for themselves; and to furnish to normal-school students and to teachers in elementary schools a book which will give them a solid grounding in the human relationships which they are eager to teach. Many books have been written on anthropogeography, but there seems to be great need of a book which sums up the present status of that subject and at the same time translates it into the simpler terminology of human geography.

"The method of the book is to take up first the physical background, not dwelling on it technically, but merely sketching the main outlines, and providing an adequate basis if the teacher wishes to go farther. In case of such relatively simple matters as water bodies, little or no physiographic treatment is deemed necessary, for such details as the difference between a meandering and braided river have little effect on man's activities. The fundamental principles of climate, on the other hand, have been quite fully treated because of their supreme importance in determining man's mode of life. Nevertheless, pure meteorology receives less attention than in most of the physiographic textbooks which are now the main reliance in teaching advanced geography.

"After the physical background has been sketched each chapter or part of the book plunges directly into the main theme, that is, the relation of the physiographic environment to man's activities. This is the part of geography which is most interesting, most practical, and most calculated to call forth genuine thought and concentrated effort on the part of the student. It is also the part which in most books is more or less incidental or secondary, whereas it is here the primary object."

The chief points in which the First Edition of this book differed from other advanced textbooks of geography were its concentration on human relationships; its emphasis on the *effects* of climate rather than upon the physical and meteorological sides of the subject; its insistence on the importance of vegetation and diet; and its interpretation of political geography. This last part of the subject does not mean the study of political divisions, but of the political relationships, both domestic and foreign, which arise out of geographic conditions.

In the present (fifth) edition these original qualities remain unchanged, except that diet is discussed in many places instead of in a separate chapter. In this edition, however, more changes have been made than in any other. Approximately half of the material is new, and many minor changes have been made in the remainder. The chief new points are as follows:

(1) The chapter entitled "The Continents and Man" has been replaced by three chapters on continents and countries. These important chapters are designed to overcome the difficulty experienced by most students because they have forgotten a large part of the geography which they learned in the elementary schools. They need to become familiar once more with the location, relief, and cities of the various countries, but they ought to do this in a mature way quite different from the memory work of earlier years. Hence in these chapters all the countries of each continent are briefly discussed so that the student refreshes his memory of the basic facts of geographic location and structure. At the same time he is made to feel that the geographic facts do not occur haphazardly, but follow definite laws. Such a preview enables him to approach the rest of the book with a much better preparation than is otherwise possible.

(2) To assist in this locational study a series of railroad maps with political boundaries and names in red has been inserted at the back of the book. It is essential that these maps be carefully studied.

(3) The two chapters on political geography at the end of the Fourth Edition have been enlarged to three in this Fifth Edition. This reflects the growing realization that boundaries, minerals, other resources, trade routes, colonies, and the general diversity of opportunities and productivity among the nations are among the chief factors which control political relationships.

(4) One of the least-understood phases of geography is the diversity of the lands in low latitudes. In order to bring this out more clearly the tropical parts of the earth are discussed in two chapters devoted respectively to the poorer and the better types. A plate (Plate II at the end of the book) has been added showing the major natural regions of the entire earth. The tropical regions, as well as others, are discussed according to its divisions.

(5) Another innovation is that a discussion of local geography, or of "microgeography," has been introduced at the end of those chapters which seem to warrant it. Suggestions are given as to ways in which the students can investigate their surroundings.

(6) The problems connected with such conditions as droughts, floods, insect pests, hurricanes, soil erosion, and the control of rivers have become

so important in late years that the chapter "Geographic Variables" has been expanded and divided into two parts.

(7) Practically all the photographs in this edition are new, and many new diagrams and maps have been included.

(8) Maps are so important that methods of map-making have been placed in a separate chapter.

(9) The questions, exercises, and problems at the end of the chapters have been reduced in number and complexity.

In preparing the three new chapters on countries the author has had the helpful advice of Professors Robert M. Brown of the Rhode Island College of Education, Earl B. Shaw of the Massachusetts State Teachers College at Worcester, Massachusetts, and George F. Howe of the Teachers College of Connecticut at New Britain. In the final chapter of the book the concept of stages of development set forth by S. van Valkenburg in his *Political Geography* has been most helpful. To all of these men I am most grateful.

E. H.

July, 1940.

NOTE: For a list of illustrations and tables see the Index under the headings: *Diagrams*, *Maps*, and *Tables*.

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NOTE TO FOURTH EDITION

AT the urgent request of many teachers a fourth edition of this book is now issued. This time the changes are so extensive that scarcely a single page is the same as in previous editions, and the whole work has been reset in fresh type. Only a few of the more notable changes can be mentioned.

In Chapter II, on *The Earth's Form and Motions,* methods of map-making receive a new treatment. In Chapter III on *The Continents,* an entirely new approach is employed, and much space is devoted to a review of the physical features of the earth as a whole. In Chapter IV on *Human Activities in Mountains and Plains,* the importance of *slopes* as an element of relief receives more prominence than formerly. Chapter VII on *Soil and the Farmer* contains not only many small additions, but also a long new section bringing out the most recent conclusions as to the relation between soils and climate. Chapters X, XI, and XII dealing with the principles of climate have also been much modified so as to make them easier to understand and at the same time more comprehensive. In the next and longest section of the book, Part VII, dealing with *Man's Regional Relationships*, the chapter on *Diet* has been omitted, and new material has been added in order to give a fuller picture of the earth's natural regions. And finally, in the last chapter, a rather full discussion of the geographic significance of Russia has been added. Many new maps are included, and many of the old ones have been revised. A new series of very complete railroad maps of the six continents deserves special mention. It supplies good material for a large number of diverse exercises which any teacher can devise to suit his own needs. A new and more convenient system of referring to illustrations by page numbers has been adopted, and all the statistical data have been brought up to date.

Many teachers and others have made suggestions which have been incorporated in this new edition, and to all of them much gratitude is due. Special thanks are due to Dr. S. Van Valkenburg and Dr. S. C. Gilfillan. The latter went over the third edition with a fine-toothed comb, making suggestions for improvements on almost every page.

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NOTE TO THIRD EDITION

THE changes in the third edition have consisted of two chief kinds: (1) Many paragraphs have been rewritten in order to bring them up to date and to take advantage of advances in geographical knowledge. (2) New maps have been substituted for those formerly used, especially in the case of those showing the distribution of minerals.

One of the important features of the present edition is a new Table of the World's Chief Products, pages 331–332, with percentages of production in cyclonic regions (p. 380 in Fourth Edition).

In preparing this new edition, I am especially indebted to Professor Stephen S. Visher of Indiana University, and to Professor S. Colomb Gilfillan, of Grinnell College.

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NOTE TO SECOND EDITION

IN the revised edition of this book large parts of Chapter II have been rewritten as have certain sections of Chapters IV, VII, X, and XIII. Minor alterations have been made in many other chapters and new problems have in some cases been added. The following persons have helped materially in the revision by critical reading of the entire book or of parts of it dealing with their specialties. Their kindness is gratefully acknowledged: G. G. Chisholm, Professor of Geography, University of Edinburgh; William Morris Davis, Professor of Geography, Harvard University; Roland M. Harper, Alabama Geological Survey; W. J. Humphreys, Professor of Meteorological Physics, United States Weather Bureau; Adolph Knopf, Associate Professor of Petrology, Yale University; D. H. Markham, Professor of Geography, University of Arkansas; H. A. Marmer, U. S. Coast and Geodetic Survey; Stephen S. Visher, Associate Professor of Geography, Indiana University; A. E. Waller, Professor of Botany, Ohio State University, and S. Colomb Gilfillan, Instructor in Sociology, University of the South.

The revision has also been facilitated through reviews by Dr. C. E. P. Brooks, Royal Meteorological Society; Professor R. D. Calkins, State Normal School, Mt. Pleasant, Michigan; the Bulletin of the Imperial Institute of the United Kingdom, the Colonies, and India; and especially Professor Harlan H. Barrows of the University of Chicago.

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NOTE TO THE TEACHER

Questions, Exercises, and Problems

In order that *Principles of Human Geography* may be effectively taught, full use should be made of the questions, exercises, and problems which follow the chapters. The paragraphs devoted to local geography should also be used as the basis of problems. Only in rare cases, however, should any one student be held responsible for all the questions, exercises, and problems in any given chapter. These vary considerably in difficulty and in subject matter, thus being adapted to students of different grades of ability and of different interests. For younger classes, such as those of the high school, only the simplest problems need be used; the more complex problems will tax the powers of the most brilliant college student. Many of the problems are elastic. They may be solved briefly and in a general way by young and relatively backward students, but need much time and thought in the hands of capable and advanced students. Again, a large number of the problems are suited to many regions in addition to the ones mentioned in the text. In all cases, however, stress should be laid on the students' own homes. The principles discussed in the text, as well as in the problems, should be applied first of all to the local region, which should serve as a starting point for an understanding of the remoter parts of the world.

Often it will be wise to assign the same problem to the whole class, but let each student take a different region. The more complex problems can sometimes be best solved by letting each student make an exhaustive study of one special phase and then uniting the results in a classroom exercise. Throughout the problems great stress should be laid on (1) accurate statistics, such as are given in the *World Almanac,* the *Statistical Yearbook of the League of Nations,* and the other publications numbered 4 to 12 in the following list of references; and (2) mapmaking in contrast to mere statements in words. In using the problems and exercises do not be in too much haste to give your students your own matured conclusions. *Show where to find the facts and how to use them, and let the students reason for themselves.*

Books for General Reference

Human geography can be effectively taught with a small equipment. The books listed below should be available so that every member of the class may be able to consult them freely.

A. General Reference Works

1. A good atlas containing physical as well as political maps. The Oxford University Press, Geo. Philip and Son, Rand McNally & Co., and several other publishers all issue inexpensive atlases that meet the requirements. Every student should own an atlas.
2. A large commercial atlas. Those published by G. P. Putnam, J. G. Bartholomew, and Rand McNally & Co. are excellent, but others are almost equally good and less expensive.
3. A good encyclopedia, preferably the Britannica or the New International.
4. *Statistical Yearbook*. League of Nations. Geneva.
5. The *World Almanac*. The World-Telegram, New York.
6. *The Statesman's Yearbook*. The Macmillan Co., New York.
7. *Graphic Summaries of Agriculture*. U. S. Department of Agriculture, Washington.
8. *Commerce Yearbook*. U. S. Department of Commerce, Washington.
9. *Statistical Abstract of the United States*. Bureau of Foreign and Domestic Commerce, Washington.
10. *Year Book of Agriculture*. U. S. Department of Agriculture, Washington.
11. *Abstract of the United States Census*. Census Bureau, Washington.
12. *International Yearbook of Agricultural Statistics*. International Institute of Agriculture, Rome.
13. A collection of elementary school geographies including *Living Geography*, by Huntington, Benson, and McMurry (Macmillan Co.); the Barrows and Parker series (Silver, Burdett); the J. Russell Smith series (J. C. Winston); Brigham and McFarland (American Book Co.); the Atwood and Thomas series (Ginn & Co.); and Dodge and Lackey (Rand McNally & Co.). Some of these, such as *Living Geography*, contain fairly extensive tables including climatic and other data not easily accessible elsewhere.
14. *Principles of Human Geography*. Vidal de la Blache. Henry Holt, New York.
15. *The New World*. Isaiah Bowman. World Book Co., Yonkers.

16. *The Pioneer Fringe*. I. Bowman. American Geographical Society, Special Publication No. 13, New York.

17. *Human Geography*. J. Brunhes, translated and edited by Dodge, Bowman, and Lecomte. Rand McNally & Co., Chicago.

18. *College Geography*. E. C. Case and D. R. Bergsmark. John Wiley & Sons, New York.

19. *Handbook of Commercial Geography*. Geo. G. Chisholm. Longmans, Green & Co., London.

20. *An Introduction to Sociology*. Edited by Davis, Barnes, *et. al*. D. C. Heath & Co., Boston (Social Aspects of Geography).

21. *Inheriting the Earth*. E. D. von Engeln. The Macmillan Co., New York.

22. *Geography and World Power*. Jas. Fairgrieve. E. P. Dutton & Co., New York. 1921.

23. *Elements of Geography*. Vernor C. Finch and Glenn T. Trewartha. McGraw-Hill Book Co., New York.

24. *Environmental Basis of Social Geography*. C. C. Huntington and F. A. Carlson. Prentice-Hall, New York.

25. *Civilization and Climate*. Ellsworth Huntington. Yale University Press, New Haven.

26. *The Character of Races*. Ellsworth Huntington. Chas. Scribner's Sons, New York.

27. *The Human Habitat*. Ellsworth Huntington. D. Van Nostrand, New York.

28. *Economic and Social Geography*. Ellsworth Huntington, F. E. Williams, and S. van Valkenburg. John Wiley & Sons, New York.

29. *An Outline of Geography*. Preston E. James. Ginn & Co., Boston.

30. *The Climates of the Continents*. W. G. Kendrew. Oxford University Press, American Branch.

31. *World Minerals and World Politics*. C. K. Leith. Whittlesey House, McGraw-Hill Book Co., New York.

32. *A Shorter Physical Geography*. Emmanuel de Martonne. The London and Norwich Press, Limited, St. Giles' Works, Norwich.

33. *College Geography*. Roderick Peattie. Ginn & Co., Boston.

34. *White Settlers in the Tropics*. A. Grenfell Price. American Geographical Society, Special Publication No. 23, New York.

35. *General Cartography*. Erwin Raisz. McGraw-Hill Book Co., New York.

36. *The Influences of Geographic Environment*. Ellen C. Semple. H. Holt & Co., New York.

37. *New Physical Geography*. Ralph S. Tarr and O. D. von Engeln. The Macmillan Co., New York.

38. *Environment, Race, and Migration.* Griffith Taylor. University of Toronto Press, Toronto.

39. *The Environmental Basis of Society.* Franklin Thomas. Century Co., New York.

40. *An Introduction to Weather and Climate.* Glenn T. Trewartha. McGraw-Hill Book Co., New York.

41. *Elments of Political Geography.* Samuel van Valkenburg. Prentice-Hall, New York.

42. *Climate: Considered Especially in Relation to Man.* R. de C. Ward. G. P. Putnam's Sons, New York.

43. *The Geographic Factor.* R. H. Whitbeck and C. J. Thomas. Century Co., New York.

44. *Geography, An Introduction to Human Ecology.* C. Langdon White and George T. Renner. D. Appleton-Century Co., New York.

45. *The Earth and the State, a Study of Political Geography.* D. W. Whittlesey. H. Holt & Co., New York.

Regional Studies and Special Reference Books

In addition to the books listed above, and others like them, every class in the principles of geography should have access to a well-selected and not too voluminous assortment of standard books on regional geography such as *The Oxford Survey of the British Empire.* The following are a few of the standard reference books on the various continents.

North America

1. *Physiographic Provinces of North America.* W. W. Atwood. Ginn & Co., Boston.

2. *Geography of North America.* G. Miller and A. E. Parkins. John Wiley & Sons, New York.

3. *Southern Regions of the United States.* H. W. Odum. University of North Carolina Press, Chapel Hill.

4. *Our Natural Resources and Their Conservation.* A. E. Parkins and J. R. Whitaker (eds.). John Wiley & Sons, New York.

5. *The South.* A. E. Parkins. John Wiley & Sons, New York.

6. *North America.* J. R. Smith. Harcourt, Brace & Co., New York.

7. *New England's Prospect.* American Geographical Society.

8. *Human Geography of the South.* R. E. Vance. University of North Carolina Press, Chapel Hill.

9. *Climates of the United States.* R. D. Ward. Ginn & Co., Boston.

10. *Major Soil Divisions of the United States.* L. A. Wolfanger. John Wiley & Sons, New York.

Latin America

11. *The Andes of Southern Peru.* I. Bowman. The American Geographical Society, Henry Holt & Co., New York.

12. *South America.* I. Bowman. Rand McNally & Co., Chicago.

13. *South America.* James Bryce. The Macmillan Co., New York.

14. *Geography of Latin America.* F. A. Carlson. Prentice-Hall, New York.

15. *Voyage of the Beagle.* C. R. Darwin. E. P. Dutton & Co., New York.

16. *South America.* C. F. Jones. Henry Holt & Co., New York.

17. *Economic Geography of South America.* R. H. Whitbeck. McGraw-Hill Book Co., New York.

Europe

18. *National Character.* Ernest Barker. Harper & Brothers, New York and London.

19. *The Geography of Europe.* R. Blanchard and R. Crist. Henry Holt & Co., New York.

20. *Economic Geography of Europe.* W. O. Blanchard and S. S. Visher. McGraw-Hill Book Co., New York.

21. *Europe; Geographical Survey.* J. F. Bogardus. Harper & Brothers, New York.

22. *The Geography of Europe.* G. D. Hubbard. D. Appleton-Century Co., New York.

23. *Southern Europe.* M. I. Newbigin. E. P. Dutton & Co., New York.

24. *Geography of the Mediterranean Region.* E. C. Semple. Henry Holt & Co., New York.

25. *The British Isles.* L. D. Stamp and S. H. Beavers. Longmans, Green & Co., New York.

26. *Geography of France.* Blanchard Todd. Rand McNally & Co., Chicago.

27. *Europe.* S. van Valkenburg and E. Huntington. John Wiley & Sons, New York.

Asia

28. *China's Geographic Foundations.* G. B. Cressey. McGraw-Hill Book Co., New York.

29. *The Pulse of Asia.* E. Huntington. Houghton Mifflin Co., Boston.

30. *West of the Pacific.* E. Huntington. Chas. Scribner's Sons, New York.

31. *The Indian Empire.* Vol. I of the Imperial Gazetteer of India, Oxford.
32. *The Continent of Asia.* L. W. Lyde. The Macmillan Co., New York.
33. *China: Land of Famine.* W. H. Mallory. American Geographical Society.
34. *Japan's Economic Position.* J. E. Orchard and D. Orchard. McGraw-Hill Book Co., New York.
35. *Asia.* L. D. Stamp. E. P. Dutton & Co., New York.
36. *A Reconnaissance Geography of Japan.* G. T. Trewartha. University of Wisconsin, Madison.

Australia

37. *Australia.* T. G. Taylor. Rand McNally & Co., Chicago.

Africa

38. *Africa.* S. Beaver and L. D. Stamp. Longmans, Green & Co., New York.
39. *Africa.* W. Fitzgerald. Methuen, London.
40. *Vegetation and Soils of Africa.* C. F. Marbut and H. L. Shantz. American Geographical Society.

Wall Maps

Effective teaching requires plenty of outline desk maps and as full a series of wall maps as possible. These should include (1) relief; (2) political divisions; (3) summer and winter temperature; (4) summer and winter rainfall; (5) vegetation; (6) resources; (7) density of population; (8) transportation; (9) commerce and industry; and (10) other conditions, such as occupations, race, religion, language, health, crops, manufactures, mineral products, and so forth. A series of world maps should first be procured, and then as many continental maps as possible, beginning with North America, or the United States, and Europe. The Denoyer—Geppert Company (Chicago) has an excellent series. The preparation of wall maps showing conditions not included in the published series is one of the best exercises for students of unusual ability. Large outline maps for this purpose can be procured through almost any dealer in geographical supplies.

PRINCIPLES OF HUMAN GEOGRAPHY

PART I

MAN'S GEOGRAPHICAL RELATIONSHIP

CHAPTER I

THE SCIENCE OF HUMAN GEOGRAPHY

Nature of Human Geography

The people in different parts of the world vary greatly in physical appearance, dress, manners, and ideals. They eat different kinds of food, build houses that vary from grass huts to skyscrapers, and enjoy pleasures as diverse as skiing and cock fights. They differ especially in their ways of work and the kinds of occupations by which they get a living. A drugstore clerk can scarcely live in the same way as a herder of llamas. Differences in language, government, education, and religion are equally conspicuous. Then, too, some people, such as the Scotch, are tall, fair-haired, active, and inventive. Others, such as the Papuans of New Guinea, are short, black, frizzy-haired, and so inactive that they rarely do anything except as their ancestors did. Some of these differences are biological; people are born with a certain complexion. Others are cultural; people have invented certain tools and worked out certain ideas in some places and not in others. Still other differences belong to the physical environment. People can mine copper only where there is copper ore in the ground.

These differences are the subject matter of human geography. The geographer's problem is to find out not only how all sorts of human conditions are distributed over the earth's surface, but also why they are distributed in their present fashion. He finds that in many cases the distribution is directly connected with geographical surroundings such as mountains, rivers, rainfall, or forests. In others it depends upon human factors, such as density of population, stage of civilization, or the physical

and mental capacities which people inherit from their ancestors. Even where human conditions are directly responsible for the distribution of certain types of human activity, further study shows that indirectly the geographical environment has a great deal to do with the matter. Hence, human geography may be defined as the study of the nature and distribution of the relationships between geographical environment and human activities and qualities.

How Human Geography May be Studied

The science of human geography may be studied in many ways. One of the best is to think of it as a series of problems, or questions for which answers must be found. Some of these problems are large and complex like the problem of how far the progress of a given people is due to the geographical conditions under which they live. For example, why are the people of the forests of Central Africa primitive hunters and those of the steppes of Central Asia ignorant cattle raisers, while those of New Jersey are a highly civilized manufacturing and commercial people? So great a problem can be solved only through the solution of many smaller ones, such as the effect of rainfall, vegetation, and distance from the ocean upon food, clothing, shelter, and tools, and especially upon man's occupations, health, energy, and racial character. Even such secondary problems, however, are too complicated to be easily solved. The way to solve them is first to study many minor problems. For example, even a child can see that since good grass does not grow in the forests of New Guinea, cattle cannot thrive there. It is equally easy to solve the problem of why the people of Central Asia, where the thermometer often drops below zero, wear sheepskin coats, while those of Central Africa, where a temperature of 70° is considered cold, wear almost no clothing. Thus human geography may be thought of as a vast series of simple problems leading to others that are more complex. To both student and teacher the solution of such problems becomes intensely interesting as soon as the spirit of the work is well understood.

In this volume we shall study some of man's chief relations to his environment and find why these relations vary from one part of the world to another. Although all the main phases of human geography will be considered, our attention will be devoted mainly to the most practical parts, which are also the most interesting. The practical parts are the problems that are usable in our daily lives, those, for instance, that help us understand what we read in books, magazines, and newspapers, that enable us to discuss current events intelligently, and that guide us in plans for business or travel.

The Physical Conditions of Human Geography

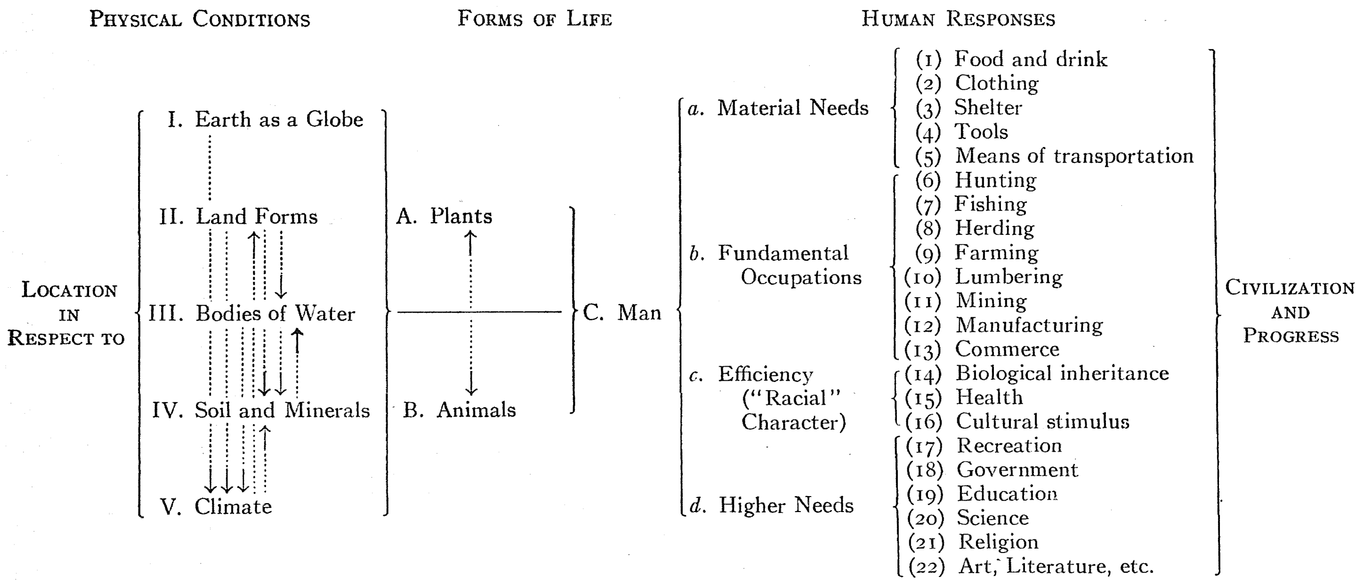
In spite of the vast number and great complexity of the problems of human geography, they can be classified into a few main types, the relation of which can be understood from the table on page 4.

I. The Earth as a Globe. Location on a rotating, globe-shaped earth is the keynote of geography. Therefore the word "location" stands on the left on page 4. Location, however, has meaning only when defined in relation to something else. It is useless to say that a place is "three miles." We must say, for example, that it is three miles south of the Millvale Post Office, thus giving both the *direction* and the *distance* from some known point. On a rotating globe, such as the earth, the primary method of defining location is by latitude and longitude. Latitude, or distance north or south of the equator, is especially important because it determines whether the climate is hot or cold. The fact that the earth is a globe is more important than we usually realize. It makes it possible to travel in all directions, and gives any one object the same weight everywhere. The fact that the globe rotates not only gives us day and night, but also forms the basis for the construction of maps, which are the most essential tool in geography. The seasons, with all their many influences, arise from the fact that the earth not only is a rotating globe, but also has an inclined axis and revolves around the sun.

II. Land Forms. The location of a place in relation to the continents, which are the greatest of the land forms mentioned on page 4, comes next in importance to location in respect to the globe. This, too, has a great effect on climate and also on other conditions. A person who lives in the the dry interior of a continent can scarcely be a sailor, or a deep-sea fisherman. Moreover, location in respect to the lands is a main factor in determining what kind of neighbors a country has. England is peculiarly well located in respect to the lands of the earth as a whole, while Sinkiang in the heart of Asia is badly located. Many minor effects of the form of the land can readily be seen. Some of the most purely agricultural counties of south central Illinois differ little in climate and only moderately in soil and elevation from similar counties in West Virginia. Nevertheless, because much of the land is level the Illinois counties have twice as many people for each square mile as do the West Virginia counties, which are rugged. Gentle relief of the land helps such people as the Belgians to move about freely and come in contact with their neighbors. The Tibetans, on the contrary, are hemmed in by steep slopes and impassable valleys.

III. Water Bodies. Oceans, lakes, and rivers often separate country from country, and thus help to establish great differences in race, language,

A. THE ELEMENTS OF HUMAN GEOGRAPHY



The arrows and their dotted extensions indicate the chief ways in which the physical conditions influence one another. Climate, for example, is influenced by the earth's spherical shape, by the form of the land, and by bodies of water such as oceans. It in turn influences the form of the earth's surface, the quality of the soil, and the nature of mineral deposits. It also influences bodies of water, but this relationship and certain others are omitted to avoid crowding.

and customs. On one side of the English Channel the people speak English and on the other French partly because the intervening body of water has prevented free intermingling. But bodies of water also serve as means of communication, and thus link people together. The hunter in Canada would find it difficult to travel far through the forest if he could not use his bark canoe on the many lakes and rivers. On a larger scale the harbors of New York, Liverpool, and Amsterdam, with their throngs of great ships, prove how closely the oceans link country to country.

IV. Soil and Minerals. A large part of the world's wealth comes from the soil. Where the soil is fine-grained, and rich in plant food, as in the plains of northern France and Indiana, the farmers are prosperous, provided the climate is right. A poor sandy soil, even with a good climate, may make a region poverty-stricken. For instance, in Mississippi and Alabama the chief physical difference between the sandy pine belt near the coast and the "Black Belt" farther inland is the soil. The infertile sandy soil was long populated only sparsely by relatively poor and illiterate white farmers, but is now being used more and more for winter vegetables. The dark, fine-grained soil of the Black Belt was formerly so rich that it became populated by aristocratic white landowners and a great number of Negro slaves. Now the soil is badly exhausted, but the dense population still remains.

Mineral wealth, as well as soil, is of vast importance. Without metal-bearing ores like those of the Lake Superior region, there would be no such thing as the machinery which runs the mills of Massachusetts. Other minerals, such as the coal of Pennsylvania, and the petroleum of Texas, are the chief sources of power for manufacturing, commerce, and motor transport. After the First World War the demand for petroleum was so insistent that every one of the great powers, including even Russia in the midst of its revolution, sent a commission to Mexico to try to get a share in that country's oil. More recently the United States and Mexico had a bad disagreement over the ownership of the Mexican oil, and Germany tried to get all of it for herself. In the second World War Romania's oil led both sides to make strenuous efforts to win that country's favor. It was one of the chief reasons why Romania abandoned the English and French when Germany seemed to be winning. The oil of Venezuela and the nitrate of Chile have also caused much friction between nations, and have been a main source of national revenue in those two countries. Much of the world's exploration has been done in search of gold and other metals. Columbus was much disappointed at finding so little gold when he discovered America.

V. Climate. The last of the five great features of physical environment enters into each of the other four, as shown by the arrows in the table.

Climate depends on location; it is greatly influenced by land forms and water bodies, and influences them in return. It also plays a great part in determining the character of many soils. The difference between the extremely desert climate of the coast of Peru and the constantly wet climate of the forested headwaters of the Amazon in Brazil, only two hundred miles to the east, is mainly due to the form or relief of the Andes. The sand dunes of Mongolia are the result of a desert climate; the "Black Earth" region of Russia owes its rich soil partly to a climate too dry for trees but good for grass; the wretched red laterites of tropical regions show what happens to a soil in a very warm, moist climate.

Climate also has a great effect on the character of the plants and animals in different regions. It permits oranges and bananas to grow in Costa Rica, and wheat in Minnesota. Still more important is the fact that man's energy is greatly influenced by climate. The Costa Rican planter cannot steadily keep on working so hard as does the Minnesota farmer. In the far North not only does the climate cause the Eskimos to be poorly nourished, but also the steady cold diminishes their mental and physical activity and makes progress difficult. When the Russians invaded Finland in December, 1939, many tanks and hundreds of men were lost because they tried to cross Lake Ladoga before the ice was thick enough. In the Congo forests, on the other hand, a hot, damp climate hampers progress by favoring malaria and other deadly diseases. Only in countries such as England, where the weather is variable, and not too extreme, can man be at his best.

The Forms of Life

A. Plants. It is almost impossible to think of the five great features of physical environment without thinking also of plants. The location of Greenland reminds us of the scarcity of vegetation and the consequent difficulty of getting a living. When we speak of the relief of the land, the word "plain" often brings to mind broad acres of rich crops, while the word "mountains" brings a picture of rough slopes covered with forests.

Even in bodies of water, plants influence man through minute forms which are eaten by fish, or other creatures such as lobsters. Thus the plants support the animals that are sought by fishermen. There is little reason for thinking of soil except as it enables corn, wheat, or grass, for example, to grow richly, as in Iowa, while in other regions, such as the sandy parts of Cape Cod, it makes the land scarcely worth cultivating. Finally, to many people, the chief indication of climatic differences is vegetation. The date palm stands for dry, hot deserts; the coconut palm for moist tropical coasts; the cotton plant for warm but somewhat more temperate regions; and tundra moss for an arctic climate.

B. Animals. Animals also influence man in a thousand ways. If the horse or ox had never been tamed, the prairies might have remained uncultivated. In most parts of Europe and America it would have been almost impossible to get rid of grass in cultivated fields if there had been no animals to draw the plow. Without sheep not only would our food supply be diminished, but we should not know where to turn for warm winter clothing. The only good substitute for wool is fur, and that, too, is derived from animals. Even more important in our daily lives are cows, which give us the most perfect of all foods. The hens that lay several billion eggs every year in the United States would be sadly missed if their cackle should forever cease. In many sections of Central Africa the tsetse fly not only kills horses, sheep, and cattle, but also transmits to man a terrible, wasting disease, while in most tropical regions the malarial mosquito continually brings sickness and helps to make people ineffective. Even in our own land animals are harmful as well as helpful. The common or typhoid fly brings many dangerous diseases; and the disgusting rat not only consumes hundreds of millions of dollars' worth of property each year, but also spreads the plague.

C. Man: How Man Responds to Geographic Surroundings. The two columns headed "Human Responses" on page 4 sum up the ways in which the distribution of human activities and qualities is influenced by the natural environment, that is, by plants and animals as well as by the physical factors numbered I to V. In the first of these columns the human responses are divided into four classes, while the second gives some of the details about these classes. In studying the first class, "Material Needs," we ask: How far do geographical surroundings lead people to use special kinds of materials in satisfying their need for food, clothing, shelter, tools, and means of transportation? Then we inquire what occupations people follow in making use of these materials.

Although all people have material needs and all follow certain occupations in order to satisfy these needs, the efficiency with which people follow their occupations varies enormously. Some are so indolent or stupid that they rarely work unless actually in want of food or other necessities; others work energetically but spasmodically and unwisely; and still others work hard, steadily, and to good purpose. Such differences, as is evident on page 4, depend partly on biological inheritance. Some individuals, and perhaps some racial groups, appear to be born with especial vigor of both body and mind. Differences in efficiency, however, depend to a large extent upon health. The distribution of health in turn depends on food, clothing, shelter, occupations, parasitic diseases, and many other factors, both physical and cultural. Its general worldwide distribution resembles that of climate more closely than anything else.

Efficiency is also greatly influenced by the stage of culture which has been reached by any group of people. This causes them to be brought up with certain habits as to work, sanitation, recreation, and so forth, and thus vastly influences their efficiency. All these biological, geographical, and cultural conditions, when taken together, give rise to what is often called racial character. This term, however, is misleading because it suggests that the obvious differences in the character of Germans, Turks, Chinese, and Hottentots, for example, are due to racial inheritance in the biological sense. As a matter of fact, much of what we call racial character is due to geographical and cultural conditions. How much is due to each of these three sets of factors—biological, geographical, and cultural—is as yet by no means clear. Hence, although we shall have much to say about the character of the people who live in various geographical environments, we shall have little to say about race.

What man gets out of life is better measured by the way he supplies his higher needs (*d* on page 4) than by the way he supplies his material needs. Every group of people has at least some elementary form of recreation, government, education, science, religion, and art. In one sense these things are not geographical. Yet the direction which they take, the resources which support them, and the degree of efficiency with which they are developed all depend largely on geographical surroundings. Although the way in which these higher needs are satisfied is the best measure of civilization, all the other classes of human responses on page 4 also influence man's degree of progress. Civilization rises high only when all the material needs are well satisfied; when the occupations are highly varied; when the pursuit of both the higher and the lower needs is carried on with efficiency; and when the higher needs are recognized as even more important than the lower.

Man's Response to Geographic Surroundings

(*a*) *Material Needs.* Let us study the second column of "Human Responses" on page 4 more carefully. Everyone must have food, but the kinds of food vary greatly from place to place. The man who lives on a remote island in an unfrequented tropical sea is likely to live largely on sago, breadfruit, coconuts, and pork, the chief products of his island, for the location is too remote to allow him to get food easily from other regions. If the island is mountainous, and it is difficult to raise crops, the water around him may lead him to get most of his food from the sea. If the soil is rich, the climate warm and damp, the vegetation luxurious, and domestic animals relatively scarce, as in the Philippines, the people may live on rice and bananas; but if the soil is gravelly, the climate dry, the vegetation merely short-lived grasses, and the number of cattle relatively large, we

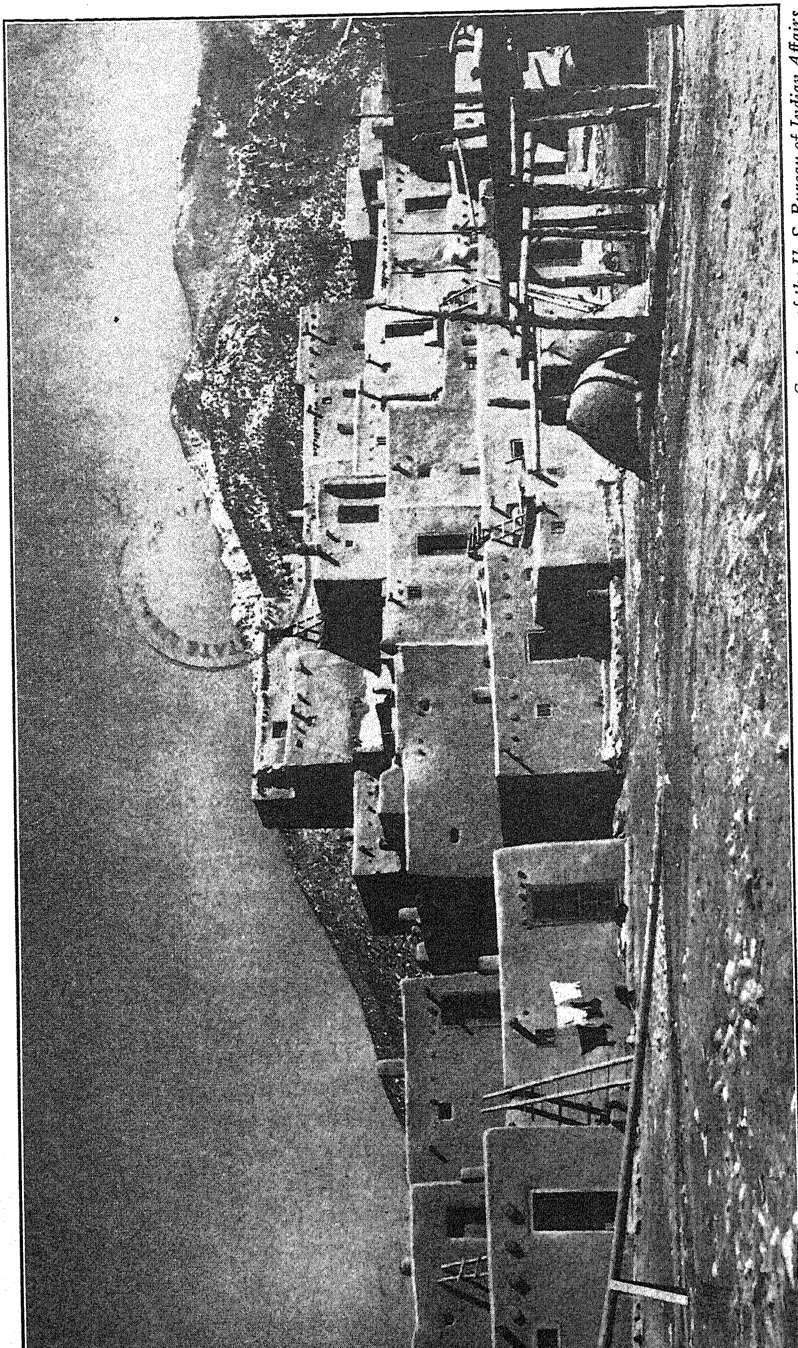
shall find people like the cowboys of western Argentina, who dry their jerked beef in the sun, and eat it with corn and beans.

So, too, with clothing, shelter, and tools. Long, heavy woolen coats, thick woolen trousers, warm woolen caps with earlaps, and high leather boots reaching to the knee—all of a reddish purple hue—are highly appropriate for the stout Buddhist priests, or lamas in the cold snowy monasteries of lofty Tibet. They would be deadly for the tall slender Shiluks of southern Sudan where the thermometer rises to at least 90° almost every day at practically all seasons. There even the thinnest cotton shirts and shorts feel uncomfortable. The natives often wear nothing but a few strings of beads or hoops of wire, and coat their whole bodies with gray, sickly-looking ashes to protect the skin from insects. Moreover, although warm wool is by far the easiest clothing material for the Tibetans to procure, it is unknown among the Shiluks.

Turning to shelter, we find that the Tibetans use low, flat-roofed, thick-walled houses made of sun-baked bricks, or of stones plastered with mud, and having no chimneys or other means of ventilation except a little hole a foot square in the wall. Such houses are easy to keep warm during the cold winters, and the roofs are pleasant places where people can bask in the sun even when snow lies many feet deep all around. The Shiluks, on the contrary, often content themselves with flimsy huts made by tying together one end of a bunch of great grass stalks ten or twelve feet high and spreading the lower end out in a circle. They want only a shelter from the hot sun. The more breeze they get the better. As for rain, it rarely falls except in afternoon showers, and is almost always so warm that it feels pleasant to the bare skin. A10 * illustrates a type of house common in dry regions where wood is scarce and there is little danger that walls and roofs made of the dried mud known as adobe will collapse because of too much rain. Contrast this with a house made mainly of small branches and big palm leaves (A385), and located in the wet tropics.

A similar contrast is seen in peoples' tools. The most important tools of the farm people near the Tibetan lamaseries are hoes, wooden plows, ox goads, rude ox carts, and big wicker baskets. The women use the baskets to gather the stones which appear on the surface of the fields each year, because the soil is washed away so rapidly. They fasten the baskets on their backs and toss the stones over their shoulders into them. Such tools and other equipment would be of little use to nomadic Shiluk cattle herders in the Nile swamps. Dugout canoes and spears with which to kill an occasional hippopotamus or other animal are what they want, although these would be useless to the Tibetans.

* Throughout this book the letters A, B, C, and D, when followed by a number, designate illustrations found on the pages indicated by the number.



Courtesy of the U. S. Bureau of Indian Affairs.

A—The Pueblo of Taos in New Mexico.

A village made of adobe (dried mud). Note flat roofs and rocky slopes indicating a dry climate, ladders for use in reaching roofs and upper stories, dome-shaped oven of adobe, small windows. Desert architecture of sedentary, corn-raising people in a region of scanty rainfall, sparse timber, and abundant clay.

(*b*) *How Geographical Surroundings Influence Eight Great Occupations.* In supplying their material needs the people of different parts of the earth generally follow the occupations in which their geographic surroundings and their degree of progress give them the greatest chance of success. The Pygmies of the dense forests of Central Africa are wandering hunters because that is the most desirable occupation for people who have not found out how to make any other profitable use of their environment. The climate is so moist and the forest so dense that they cannot practice agriculture; the larger races of Negroes keep the Pygmies away from the rivers and other bodies of water where fish are abundant; cattle will not thrive; it is useless to cut lumber, for there is no market for it; there are no valuable ores, or else they are so covered with soil that no one has found them, and hence there is no mining. More advanced occupations such as manufacturing and commerce are beyond the capacity of people who live in such surroundings and in such a stage of culture.

Similarly on the Labrador coast, fishing is the main occupation, and even that is sometimes precarious. In considerable parts of Sonora in northern Mexico the climate is too dry for agriculture, but cattle can live on the short grass, which remains green for a month or two and furnishes pasturage for many months after it turns brown. Hence the people are cattle herders.

In more favored regions such as Denmark the levelness, climate, and absence of other resources cause agriculture to be the great occupation. In similar fashion the great forests are almost the only resource of the mountains of northern Sweden, so that the inhabitants are lumbermen, just as in Spitzbergen (Svalbard) the low temperature and the presence of rich ores make mining practically the only occupation. England, like Spitzbergen, possesses valuable minerals in the shape of beds of coal and iron, and these not only foster mining, but also help manufacturing to take the lead. In Holland, on the other hand, the location of the country on the shores of the North Sea and at the mouth of the Rhine, between Germany and England, makes it natural that commerce and transportation should be leading occupations.

In the more advanced parts of the world several occupations are always carried on close together. One simple kind of occupation may have prevailed at first, but others are introduced until there may be hundreds. Four centuries ago all the people of Pennsylvania, for example, were Indians who lived mainly by hunting and fishing. Some of the early colonists lived in the same way. Pennsylvania is a fine place for hunting and fishing, but today these occupations support very few people. The reason is that such occupations use only a few of the state's resources and possibilities. Most of the early colonists began cutting lumber, not only to

clear the land, but also to get firewood and lumber for houses, tools, furniture, and ships. In our day a number of Pennsylvanians are still lumbermen, but this occupation also uses only a small part of the natural resources. The colonists knew this, and most of them took up farming. Today the farmers are many times as numerous as the lumbermen, fishermen, and hunters. But farming, when taken by itself, does not use the rivers, or the easy routes through the hills.

Even before the farmers began work Europeans had seen that they could make a living by buying furs from the Indians, transporting them along the easiest routes by land and water, and selling them at the coast. Thus the white men took the first steps in establishing the occupations of transportation and trade. As soon as the farmers began raising crops these occupations increased in importance, and now many people are engaged in them. Then people saw that they could get an extra profit by changing wool into cloth, wood into furniture, milk into butter and cheese, or iron ore into hoes. This meant the establishment of manufacturing, which is now the most common occupation in Pennsylvania. In order to get iron and other metals out of the rocks, there was need of miners. When the steam engine was invented, much coal was required. Thus mining on a large scale was added to the occupations. There are other occupations too. In the past the Pennsylvanians have used petroleum for gasoline, water for power, sand for glass, and cotton from other regions for cloth. In the future no one knows what new natural resources or other features of their geographical surroundings they may put to some new use.

Each great occupation has its own special ways both of working and of living. Farmers cannot well live in cities. Hunters, lumbermen, and farmers all work in different ways. So do people engaged in transportation, trade, or manufacturing. Sometimes these ways are as different as if people lived in different countries. All these occupations and modes of life have developed under the influence of the same general geographic environment. They are responses, however, to different factors in that environment. Moreover, the human response to each factor varies according to the stage reached by civilization. Backward countries have only a few occupations and use only a few of the natural resources and geographical opportunities. Advanced countries always have many occupations and use a large share of the resources and opportunities.

(*c*) *How Efficiency Depends on Geographical Surroundings.* The great trouble with most people and with most races is not that they do not have ability, but that they do not make full use of what they have. They are lazy, lack will-power, or find it difficult to concentrate on their work. Much of this inefficiency is due to lack of health and energy.

Health and energy, as everyone can see, are largely influenced by people's occupations and by the way in which their material needs are met. Many a man has poor health because he eats poor food, or eats good food too rapidly, or in too large amounts. Others lack energy because they dress unwisely, live in houses that are not properly ventilated, use machines that necessitate unnatural positions, ride too much in automobiles, or follow occupations which keep them in offices and factories instead of outdoors. These reasons for lack of health and energy are closely bound up with geography, because man's occupations, food, clothing, and shelter all depend largely on physical environment.

Certain geographic conditions, however, have a much more direct effect, and are so powerful that not even the strongest races have yet learned to overcome them. For example, the Dutch are a wonderful people, possessed of fine minds and great energy; but when they go to such places as Borneo, where the climate is tropical, they rarely accomplish as much as in their own land, for they suffer in health and energy. This is due partly to distinct diseases, partly to the direct effect of climate, as we ourselves see when we feel dull, listless, or dreamy in hot weather, and partly to the modes of life that tend to grow up in each special type of climate. Thus it appears that a considerable part of what we call the character of a race or nation, by which we often mean its efficiency, depends upon geographical surroundings.

(*d*) *Why Man's Higher Needs Depend on Geography.* That country stands highest in which the greatest number of people take an intelligent and active interest in government, education, science, religion, art, literature, and other cultural activities. These means of satisfying the higher needs are much influenced by geographic surroundings even though they also depend largely upon racial character, the accidents of historical development, and the presence of men of genius. The geographical influences act mainly through five agencies: (1) density of population; (2) degree of prosperity; (3) degree of isolation; (4) local differences in interests, resources, and occupations; and (5) degree of energy.

1. Where the population is dense people can easily get together and talk things over; they can all be within reach of law courts, election places, schools, churches, and art museums; and they can learn how to adapt themselves to new surroundings much more easily than can people who are scattered in small groups over a large area. That is one reason why southern Scotland is less conservative and better educated than the northern part of the country. Nevertheless, too great a density of population is one of the greatest curses, as is evident in India and China. In this respect, as in many others, a certain middle ground, or *optimum,* is the most desirable condition. The optimum, or best condition, far from either

extreme, is very important in geography. It is what Horace called the "golden mean."

2. Where favorable surroundings like those of Ohio make a community rich and prosperous it can afford to maintain a good government and support teachers, scientists, clergymen, and artists. A region like eastern Quebec with poorer soil and a less favorable climate cannot afford to spend so much.

3. China illustrates the effect of geographical isolation on the higher activities. Although Buddhism came from India, the intervening mountains have prevented the two countries from having much influence on each other. The sea long shut China off from the rest of the world. Now, however, the old isolation is breaking down. So we see the Chinese government change from an absolute monarchy to a republic, and come into troubled contact not only with Japan, but also with Russia, Europe, and America. The old system of learning literary masterpieces by rote gives place to the study of practical sciences; witchcraft is beginning to be replaced by scientific medicine; manufacturing plants are established; railroads are laid through cemeteries that once were sacred; and there is agitation to replace the thousands of difficult written characters by something simpler.

4. Geographical conditions often have a direct effect on art, religion, government, education, and other phases of civilization. For instance, the scattered location of the parts of the British Empire causes the most progressive of them to be far more independent in respect to London than are our own states in respect to our capital at Washington. In the same way, because our states cover a large area and have different climates and different relations to the sea, they can be joined happily in a single country only if the various parts have more self-government than the "departments" of France, which lie near each other and have less divergence of interests. Again, in education, consider the contrast between the numerous trade schools in England, where coal, iron, and other factors combine to encourage manufacturing, and the schools of an agricultural country like Argentina, where commercial and industrial subjects find little place.

So, too, Germany has turned especially to chemistry, partly because rich deposits of unusual minerals, especially at Stassfurt, and the use of the beet for sugar gave the Germans great interest in that science. In like fashion their wide use of the sea has helped to make the English the chief investigators of the science of oceanography; California's clear air aids that state in holding an exalted place in astronomy, with the world's two largest telescopes.

Every religion is at least modified by its surroundings, especially those of its birthplace. The objects of worship are often determined by geog-

raphy. In India where the coming of the rain is uncertain, the rain god is one of the chief deities. In the lofty plateaus of the Central Andes, where one is rarely warm, except when actually in the sunlight, sun worship prevails. In Egypt the Nile was once an object of religious adoration. The Egyptians knew that their very lives depended upon it. The fact that both Judaism and Christianity sprang from a dry region where sheep herding is one of the chief occupations is evident in many parts of the Bible: "I am the good shepherd and know my sheep." "The shepherd giveth his life for his sheep." "The Lord is my shepherd; I shall not want. He maketh me to lie down in green pastures: He leadeth me beside the still waters." Such quotations reflect a leading occupation of Palestine.

The art of a rainy country like Japan, where wood, silk, and copper are abundant, where good building stone is rare and where earthquakes are common, is bound to differ greatly from that of a dry country like Greece, where easily worked marble is more common than good lumber, and where there is little silk and few metals. The Japanese build wooden temples with huge eaves, and place in them paintings on silk and Buddhas cast in bronze; the Greeks built flat-roofed temples of stone, and filled them with marble statues. Not only the materials used in art but likewise the subjects show the influence of environment. In Japan venerable scraggly pine trees and symmetrical volcanoes are among the chief subjects of art; in Egypt the kind of water lily known as the lotus became a conspicuous ornament of architecture. Similarly the acanthus leaf was characteristic of the art of Greece, where that bold, handsome plant thrives in the dry soil. Even in the most progressive countries the art reflects local conditions.

5. Lastly, the degree of perfection to which a country carries its government, education, science, religion, and art depends largely on the energy of the people, as well as upon the stage of civilization. Energy, as we have just seen, is especially influenced by climate and by the effect of climate upon diet and mode of life. Hence good-government clubs, educational societies, scientific associations, philanthropic organizations, and musical clubs are vastly more numerous in a country such as Denmark, with a stimulating climate, than in a tropical country such as Siam.

CHAPTER II

AN EXAMPLE OF HUMAN GEOGRAPHY

Khirghiz Nomads of Central Asia

The nature of human geography may be illustrated by an example. Some of the Khirghiz of Central Asia are wandering herdsmen, or pastoral nomads, who live in the great Tien Shan Plateau of Central Asia in summer, and descend to the valleys and the lowland plain in winter. They are densely ignorant of such things as manufacturing, science, and art, but know much about animals, weather, and mountains. Their furniture consists mainly of bags, saddles, and quilts. Sitting cross-legged on the bare ground, or on the woolen rugs which are the most beautiful of their few manufactures, they eat their meals with their fingers from the common dish. Often their diet for months consists of sour milk, cheese, and meat with very little bread and no vegetables or fruit. According to our standards the Khirghiz are dirty, lazy, and unprogressive. To offset these unfortunate traits the nomadic Khirghiz are delightfully hospitable, quite honest, and so bold and hardy that one cannot help admiring them.

Geographical Environment

How Their Location Isolates the Khirghiz. In saying that the Khirghiz live in Central Asia we have already stated the main fact as to their location in respect to the earth as a whole. This carries with it the idea of middle latitudes and of a mid-continental location with all that these imply as to climate and contacts with other countries. Few other regions are more remote from the sea and from the broadening influences which the great waters carry with them. On the south the Khirghiz are separated from India by the great deserts of Sinkiang (Chinese Turkestan) and the huge desolate plateau of Tibet. On the east and west they are also shut in by deserts so that they come into contact mainly with nomads like themselves—Mongols on one side and Turkomans on the other. Only toward the north, where the desert is less severe, do the Khirghiz meet civilized people, the Russians, but even that contact is slight. Thus isolation is the keynote of the Khirghiz location.

How Plains, Mountains, and Plateaus Encompass the Khirghiz. Broad plains to the north and high mountains and vast plateaus to the south are

the land forms among which the Khirghiz have their home. It is a wonderful experience to start in the broad plain and ride southward on horseback, with the Khirghiz. At first our vision is limited only by the unbroken horizon, except where distant blue mountains break the skyline far to the south. The next day's march brings us among low hills; then the hills become so high and numerous that the trail winds up a valley instead of going straight toward its destination. After several days' riding, we enter a mountain gorge, where the cliffs rise steeply on each side and the trail can scarcely find a foothold. Soon there is no room at the bottom of the gorge, and the trail must zigzag up a steep rocky slope. There a misstep, or a slip on an unnoticed bit of ice, sometimes sends a horse tumbling hundreds of feet into the river. Finally, the gorge opens out upon a fine plateau, where broad, green, basin-shaped plains lie pleasantly spread out at heights of 8,000 to 12,000 feet. On every side rise snow-covered mountains, wonderfully tinted with blue or pink, and studded here and there with glaciers. Such are the wandering places of the Khirghiz nomads.

The Part Played by Water Bodies. In the land of the Khirghiz there are salt lakes such as Balkash in the desert lowland, and fresh lakes of rare beauty, such as Issik Kul among the mountains. These, however, have little effect on the lives of the nomads, except that certain dry lake bottoms furnish salt. Far more important are the rivers; not only do they serve as drinking places for cattle, but they have carved the valleys up which the Khirghiz climb to the mountains. Such rivers are very hard to cross when the snow is melting in the spring. Sometimes a Khirghiz horseman tries to cross when the water is too high; his horse stumbles amid the boulders; and horse and rider are swept down several hundred yards in the icy water. Sometimes the streams cannot be crossed until the trail approaches their sources far out of its direct course.

One of the most noticeable habits of the Khirghiz rivers is the suddenness with which they rise. By night in summer the mountains are cold and no snow melts, so that in the morning the rivers are low. By day there is much melting, and the streams swell rapidly. In some rivers the flood comes down at a regular hour each day. In traversing the valley of such a river the Khirghiz often urge their horses to a gallop in order to reach a ford before the thick muddy tide of melted snow comes pouring down.

To the Khirghiz the most important water is the springs beside which they camp. Among the mountains these are numerous, but in the dry lowlands, far from the rivers, their rarity makes them very precious. In summer large stretches are uninhabitable because no drinking water is obtainable.

Why Soil and Minerals Have Little Influence. Soil and minerals have little effect on the Khirghiz. The soil is excellent, but its use is limited to grass, for the climate prevents the growth of crops. The mineral wealth thus far discovered shows that some day it may be important, but isolation has kept the Khirghiz so backward that they have not yet learned to use the minerals of their mountains.

The Nature of the Climate. The Khirghiz are so remote from the ocean that the winds have largely lost their moisture before penetrating so far inland. Hence the lowlands are barren steppes. Fortunately what little precipitation there is comes mainly in summer rather than winter, but it is never enough to support agriculture. There, even more than in other continental interiors of middle latitudes, the contrast between the seasons is great, for the summers are steadily hot, whereas the winters are long and bitterly cold with occasional fierce, wild gales.

Among the mountains the fall of snow and rain is much greater than on the plains. In winter the mountains are so cold and snowy that no one can live there. In summer they are cool and wet, but not unpleasant. Frost may occur at night on the high plateaus even in July, and showers are fairly common, but the bright clear days during much of the summer are delightful.

How the Climate Determines the Vegetation. The plants that flourish in a climate such as that of the Khirghiz are limited. In the dry lowland plains there is a fairly good growth of short grass during the summer, but it is the thin grass of the steppes and not the rich verdure of the prairies. Where water is available for irrigation excellent crops can be grown, but such places are too rare to support any great number of people. As one passes from the treeless grassy steppes into the mountains a fringe of willow trees is often seen beside the streams, but real forests begin only at a height of perhaps 6,000 feet, where the rainfall is sufficient for tree growth. Above that for about 2,000 feet the slopes are clothed with pine forests, but the climate becomes too cold for trees and grass again predominates. This time it is the beautiful thick, turfy, flower-studded grass of the alpine heights, for which the cool, wet summer is ideal. In some places it grows a foot or more tall and is full of daisies, red peonies, and other bright flowers. Elsewhere it is shorter and spangled with thousands of wild pansies. Finally, near the snowline, the grass gives place to lichens and moss. Grass is the dominant vegetation of the home of the Khirghiz. No other form of natural life is important, for wild animals, birds, and insects play little part in people's daily routine.

How Man Responds to the Environment: Grasslands. In such an environment what mode of life should we expect? In other words, how is man to get a living? Since grass is the chief resource, the best way is to

keep domestic animals such as sheep, cows, yaks, horses, or two-humped Bactrian camels. Since each family needs many animals, the grass in any one place is eaten up in a month or two. Moreover, the most nutritious grass grows in the high plateau where it is deeply buried in snow except for three or four months in summer. Hence the most practicable mode of life is pastoral nomadism. That is, the Khirghiz must keep animals, and drive them from pasture to pasture, thus practicing what is called *transhumance,* or regular seasonal migration. In summer the herdsman lives on the high plateaus among the mountains with his flocks and herds; but as winter approaches, the animals must gradually be driven downward to the lowest valleys, and out upon the plains where hay has been stored, and where relatively permanent camps are occupied for three or four months in mid-winter.

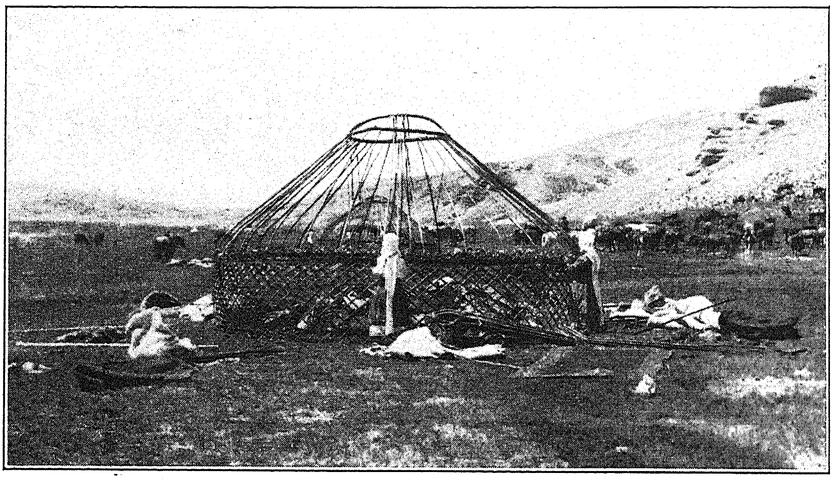
Why Animals Furnish Most of the Food. Such being their mode of life, let us see how the Khirghiz respond to the environment in other respects. Why is their diet so largely limited to milk, cheese, and meat? Since the summers are too cold for gardens, vegetables are almost unknown. Meat, too, is by no means eaten regularly, as one might suppose. Some of the young animals that grow up each year must be kept to increase the flock, and replace those lost in storms or eaten by wolves. Most of the rest must be exchanged for flour, cloth, knives, or other necessities. Hence only a few can be eaten. Milk is the staple food. Part of it is made into butter, or hard sour cheese, and kept for weeks or months. The rest is used as milk, but not until it has become sour. The Khirghiz have learned that, if milk is used in large quantities, it is more healthful sour than fresh.

To many a Khirghiz boy or girl bread is more of a luxury than cake to a child in America. The flour must be brought long distances on horses or camels. The supply may be exhausted long before the summer stay in the mountains is over. A Khirghiz mother often takes great pains to stow her little store of bread where the children will not find it and be tempted to eat it without permission. As there is no fuel except dry grass, or the dried dung of animals, and as stoves are too heavy to be easily transported, the bread is baked in thin sheets over open fires, or perhaps the dough is cut into cubes and cooked in fat like doughnuts.

The Relation of Clothing to Environment. The clothing of the Khirghiz is adapted to life in the cool damp mountains in summer and in the cold lowlands in winter. At all seasons both men and women wear thick padded gowns that shed the rain, and high boots for walking in the wet grass and among the cattle. Much of their clothing is made from the wool of their sheep and the skins of their animals. The men wear great caps of sheepskin with the wool on the outside, and everyone has a sheepskin coat

made so that it can be worn with the wool in or out according to the weather. The women wear head coverings of cotton cloth from Russia. They wind long embroidered strips into head-dresses a foot high. Both men and women keep their hands warm and dry by means of sleeves that extend a foot or so below the hands. It is amusing to watch them throw back their sleeves when they eat, or begin to work. The necessity of selling animals to obtain cloth for clothing is one of the chief reasons for what little commerce there is among the Khirghiz.

The Movable Homes of the Nomads. People who frequently migrate must use a shelter that can readily be taken down, packed on animals, and set up in a new site. A tent is admirably adapted to such purposes. The



A—Khirghiz Women Erecting a Felt Tent on the Tien Shan Plateau. Such tents are used north of the great central mountains that extend from northern Persia to central China.

tent of the Khirghiz is round and covered with a thick felt made from the wool of their sheep (A20). A folding lattice fence of willow forms a circle twelve to fifteen feet in diameter. From the top of this, light poles converge upward toward a large circular opening. Over the framework thus formed the felts are smoothly stretched, and are most effective in keeping out cold, rain, and wind.

The Tools of Pastoral Nomads. The heading "tools" on page 4 includes not only ordinary tools, but also all kinds of implements, utensils, and even machines—in fact everything that people make in order to help themselves in some occupation, or art, or in transportation and communication. Since all of a family's goods are carried on the backs of animals every few weeks, special kinds of utensils are needed. Earthenware dishes

are too easily breakable and metal bowls too heavy. Therefore, milk, cheese, and butter are kept in whole sheepskins partially tanned. When the family sits down to a meal a great wooden bowl holds the sour milk, soup, or meat. As forks and spoons cannot easily be made and are usually a luxury beyond the reach of the Khirghiz, everyone eats with his fingers from the same dish. Since furniture is too awkward and heavy to be transported on the backs of animals, rugs from the wool of the sheep take the place of chairs, tables, and beds.

How the Khirghiz Family Moves. A Khirghiz migration is an interesting sight. At dawn a group of tents stands on the green turf at the base of a high cliff. An hour later the tents have been pulled down by the women, while the men have started on the day's journey with the slow-moving sheep. A five-year-old child leads a snarling camel to the pile of felts, poles, and lattice where his mother has just pulled down the tent. A jerk on the rope tied to a pin in the creature's nose makes it kneel in spite of its fierce snarls. The mother and an older boy tie the tent poles, a box or two, and some bags and rugs on the animal's back. A big sister fastens some wooden bowls and some sheepskins of sour milk and cheese on one side, and on the other ties the baby's cradle. The baby is put into the cradle, a big rug is tied firmly over it, and the camel, grunting and complaining, is led away to take his place at the head of a string of other camels. The mother and all the children down to the five-year-old youngster follow on horseback. By nightfall the tents are set up ten or fifteen miles away, and the new encampment looks as comfortable as the old.

The Work of Herding Animals. In following the outline of human responses on page 4 we have now reached the occupations (items 6-14). All the Khirghiz, as we have seen, are stock-keepers. Their life is sometimes easy and at others very strenuous. Some of the men go out with the sheep and sit around all day doing nothing except occasionally bring back a straying sheep. Others, on horseback, round up the cattle or yaks to see if all are on hand and perhaps to pick out one for sale; still others, with nooses tied to the end of what look like fishing poles, gallop off to catch horses when more are needed.

Occasionally, however, the Khirghiz must ride all day to recover stray animals. Wolves must sometimes be fought, and during the great snow storms the sheep must be carried to safety, one by one. Thus the Khirghiz men are forced to tremendous exertions for a while. They come back to the tents so tired that they lie down and do almost nothing for days. As the women milk the animals and do all the routine work, the occupation of herding tends to make the men lazy. They laugh at the danger of fording a roaring torrent, which makes the city man pale, but they do not

know how to stick to hard, steady work, for their occupation does not require it.

Why Manufacturing and Commerce Are Backward. This lack of steadfastness, the difficulties of transportation, the isolation, and the lack of other incentives cause Khirghiz industries and commerce to be poorly developed. The women weave, or rather knot, beautiful rugs of wool, which are prized even in Europe and America for their harmonious colors and pleasing patterns. The women also make gay felts by beating wool of various colors into a firm waterproof mass; the skins of animals are tanned; and a few other simple operations are carried on. From the mate-

A—Milking a Sheep at a Khirghiz Encampment in the Tien Shan Mountains.

Married women wear elaborate white embroidered headdresses; unmarried girls wear beautiful fur caps.

rials available to pastoral nomads, the Khirghiz make the things that they need and can easily carry, but that is the limit of industrial development.

Commerce is equally backward. In the autumn, droves of sheep, horses, and camels, and perhaps a few cattle are driven to a distant town for sale. Flour, cloth, guns, and other small articles are brought back. Even in these simple transactions—their only commercial dealings—the nomads are frequently cheated by the city men, for though the Khirghiz dare traverse the most narrow and dangerous trails, their daily life gives them no skill in the art of buying and selling.

Are the Khirghiz Efficient? It is not easy to measure the efficiency of the Khirghiz. No one yet knows whether the Turanian race to which

they belong stands higher or lower in mental power than the white race, or the yellow Mongolian race to which the Chinese belong. We have seen that their occupation tends to make the Khirghiz lazy and inefficient. As to health no figures are available, but the Khirghiz are probably not long-lived. They seem strong and hearty, however, and the outdoor occupation of both men and women, as well as the life in the open tents and a diet with abundant milk, is certainly beneficial. How valuable these are is evident when the Khirghiz move to the Russian villages, live in close, stuffy houses, and eat a great deal of bread with little milk and vegetables. Under such circumstances their health suffers at once. Even when living out of doors the Khirghiz suffer some disadvantages. The winter is so long, cold, and monotonous that it saps their vitality. Little fires of the dried dung of cattle are the only help against the cold. The cool summer, however, is excellent, except that there is a good deal of exposure to dampness and chills.

The Exhilarating Recreation of the Herders. The Khirghiz methods of satisfying higher needs (items 17-22) are relatively simple. Their favorite sports are such as fit a strong, hardy race of horsemen. In one sport a group of horsemen, sometimes as many as 30 or 40, strive to skin a dead calf and carry off the hide, while the others try to pull it away and skin it themselves. At first the calf is thrown on the ground in the midst of a circle of riders. At the word everyone whips his horse into the center, all lean over and try to pick up the dead animal, and there is frantic confusion. The one who finally gets the calf darts out of the plunging, kicking group of horses, throws his leg over the animal and whips out his knife to begin skinning as he rides. The horses gallop furiously, the men shout wildly, and one thinks that half the riders will be killed. Finally a skillful rival overtakes the leader, yanks the calf from under his leg, and goes on with the skinning. The same thing soon happens to the rival; and so it goes until someone dares gallop down a treacherous slope, or ford a rushing river, and thus get far enough away from the rest to pull the skin off, and win the prize. Such a game is as good a recreation as could be devised, for it gives health, strength, and good sport, and also efficiency in the hardest part of the herder's occupation.

How Environment Influences the Higher Needs of the Khirghiz. Where geographical conditions cause nomadic herding to be the chief occupation, man's higher needs are usually neglected. Thus the Khirghiz, secure in their remote grasslands, pay little attention to the central government. If a crime is committed, if a feud breaks out, or if a new trial is needed, they take the matter into their own hands. In each group of relatives who pitch their tents together the oldest or the most competent of the older men is the chief or patriarch. He rules by his sense of

justice and by the dictates of custom instead of by written laws such as ours.

Among nomads such as the Khirghiz, education and science are even less developed than government. The individual communities are too small to have schools. The absence of contact with outside people, the low stage of culture, and their own lack of inquisitiveness prevent the Khirghiz from making scientific discoveries. In religion they are content to follow many Mohammedan customs, but are too isolated to get many new ideas, or even to follow fully the practices of other Mohammedans. Art finds almost its only chance for expression in the woolen rugs, bags, and felts which the Khirghiz use for many purposes. Thus civilization remains stationary. The Khirghiz are not savages, but the gulf between them and the more enlightened nations is growing wider. The influence of European civilization has begun to reach them, but their mode of life will probably change only a little so long as they depend chiefly upon the grass of the plains and high plateaus.

Geography and Other Influences

In spite of its great importance, as illustrated by the life of the Khirghiz, we must think of geography as only one of the factors that influence human character. Some persons are born with high ability and some without. A man of great energy and fine mind, even in a debilitating climate far from educational advantages and other opportunities, is worth more than a weak, stupid man who lives in the most favorable place in the world. Even an apparently dull boy who has the determination to make himself of value will succeed in a poor environment better than will a bright boy who lives amid better surroundings but has not the will to live up to high ideals. So, too, the right kind of government, a good education, or a religion which leads people to serve the public, instead of seeking their own petty ambitions, may make people amount to more in a poor environment than in a good one without such influences. Moreover, mankind is constantly learning to overcome the influence of unfavorable circumstances, and is even causing them to help him. Thus although good geographical surroundings are highly desirable, it must constantly be remembered that they are only one of the great factors which determine the progress of a nation.

Local Geography

A large number of the topics which we shall study in this book are illustrated locally. Some geographers speak of local geography as *micro-geography,* or the geography of small spaces. Such geography is especially interesting because everyone can study it at first hand. Therefore at the

ends of many chapters we shall explain how the topics treated in the chapter can be studied locally. In this chapter we have surveyed the general field of human geography, and have studied an example of a special *mode of life* which prevails among the nomadic pastoral Khirghiz. Of course the Khirghiz way of living is very simple and its connection with the geographic environment is easily seen, whereas our mode of life is complex and the connection is more difficult to follow. Nevertheless, the connection between mode of life and geographic environment is always present.

The kinds of houses in any given section of a village or city afford at least a slight indication of the way in which people live. In the United States every center of population larger than a village comprises a certain number of people who live in comparatively large one-family houses surrounded by lawns. These represent a prosperous, comfortable mode of life followed by business executives, professional men, and certain others. One of the problems before the local geographer is to discover how these houses are distributed and why. Are they scattered hit or miss among smaller houses, factories, and stores? Do they form groups here and there? Are they all collected together in one place? If they are found in special locations, as is almost universally the case, what kinds of places attract people of each particular type? How far is the location of the homes of people engaged in different occupations influenced by hills, bodies of water, parks, railroads, factories, or motor highways?

Other sections of a city consist largely of small one-family houses with only a few feet of lawn. Elsewhere the dominant type of dwelling may be detached houses for two or more families, expensive apartment houses, or cheap, crowded, solid blocks of tenement houses. Each type of dwelling is mainly inhabited by people whose mode of life is somewhat different from that of other sections of the city. How much tendency is there for any of these types to be located on steep hillsides, or on low land where perhaps the cellars are poorly drained and there is danger of floods? Do any of them show a special tendency to be located near railroads, waterways, factories, or bus lines? Even within a few blocks the general mode of life may change rapidly as one goes from the top to the bottom of a hill, from the railroad or the river to the main business street, or from a park to a factory district. Outside the city there are similar local differences. In a ride of a few miles one may see residence suburbs, market gardens, dairy farms, subsistence farms, and areas left unused or devoted to forests. It is well worth while to make notes on these, and perhaps to make a map of them. No matter what methods of study we employ, it is interesting to discover how far our local surroundings illustrate the table on page 4.

QUESTIONS AND EXERCISES *

1. Make a list of the natural resources which are mentioned in this chapter as being used by the Khirghiz. Make another list of resources which probably exist in the land of the Khirghiz but are not used by them.

2. Compare the most common occupations and recreations of your own region with those of the Khirghiz. What geographical reasons can you see for differences?

3. Write a comparison showing what A20 and A10 illustrate as to the effect of geographical environment and mode of life upon the raw materials and methods used in building dwellings among the Khirghiz and the Pueblo Indians.

4. On the basis of your own knowledge and of any books that you choose write a brief description of some backward people, taking the Khirghiz as a model.

5. After each item of the list of human responses on page 4 make an entry showing how this type of response is treated in the description of the Khirghiz in this chapter.

* It is often advisable for each student to complete one or two exercises fully rather than a larger number superficially.

PART II

MAN'S RELATION TO THE EARTH AS A GLOBE

CHAPTER III

EFFECT OF THE EARTH'S FORM AND MOTIONS

The Earth as a Globe

The Significance of the Earth's Shape. The qualities which the earth possesses by reason of being a rotating, spheroidal planet revolving around the sun have an incalculable influence upon human affairs. Nevertheless it is difficult to describe this influence because we have nothing different with which to compare it. If the earth were altered in shape even a little, if it rotated or revolved more slowly, or if it were composed of different materials, the development of plants, animals, and man would have been correspondingly altered. For example, the earth is an oblate spheroid, that is, a sphere flattened at the poles and bulging at the equator, so that the diameter from pole to pole is about 7,900 miles, or nearly 27 miles less than at the equator. If the solid part of the earth were a perfect sphere, the effect would be the same as if there were a gentle slope downward all the way from the poles to the equator. Hence an ocean of great depth would completely surround the earth in low latitudes, and there would be no land there. Each pole would be surrounded by an enormous circular continent where the winter would be very dry and almost incredibly windy and cold. In summer strong winds would blow inward from the equatorial ocean, and the low belt along the coast would be extremely rainy as well as warm. The bitterly cold and violent winds of winter, however, would make even this belt almost uninhabitable according to our ideas. Plants, animals, and men, if they existed at all, would have to be different from those with which we are familiar. It is useless to pursue the subject further; this is enough to show how completely all life is adapted to a globe with a definite shape, size, and set of motions.

How We Know the Earth's Shape and Motions. The evidence that the earth is a globe is abundant. The hull of a distant receding ship dis-

appears before the sails or smokestacks. Hence the intervening surface must be curved. The altitude of the stars changes by a practically uniform number of degrees for each hundred miles that one travels northward or southward. This is possible only on a globular earth. Moreover, thousands of people have actually gone around the globe in many different directions since Magellan's ship first did so. Airplane photographs taken at a great height actually show the horizon as curved, not flat.

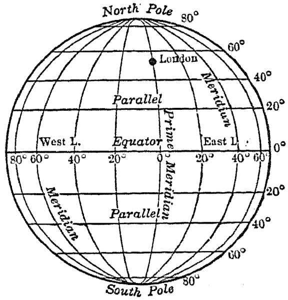
The evidence that the earth rotates once in twenty-four hours on an axis is not so clear as the evidence that it is a globe. The sun, moon, and stars, to be sure, rise and set as if the earth rotated, but this might be because each heavenly body revolves around the earth, as was supposed by the ancients. So firmly was this idea established that, when Copernicus and Galileo taught that the earth's rotation accounts for day and night and for the rising and setting of the stars, they risked violent persecution and even death. One of the most convincing proofs that the earth rotates is the course of a ball dropped from a great height. Barring a slight deflection due to the varying density of different parts of the earth, a plumb line suspended from a lofty structure such as the Eiffel Tower in Paris points straight toward the earth's center. If a ball be dropped from the point of suspension, it will not strike the earth at the point toward which the plumb line is directed, but an inch or more to the east. During the few seconds while the ball is falling both ball and earth move eastward by rotation. The ball falls perfectly straight, but because it starts at a point outside the earth's surface, it has an eastward motion greater than that of the point on the surface below it.

There is plenty of proof that the earth not only rotates on its axis, but also revolves around the sun once in about 365¼ days. As soon as it was proved that the earth rotates, it was clear that one of two things must be true. Either the sun must revolve around the earth in a very wabbly, changeable path, far north in summer and far south in winter, or the earth must revolve around the sun. Measurements of the very slightly different angle at which we see the nearer stars at dates six months apart prove that the earth is the body that does the revolving. The change from the high sun at noon in June to the low sun at noon in December proves that the earth's axis is inclined to the plane of the earth's orbit instead of being vertical. This orbital plane can be understood by thinking of the earth's path around the sun as a huge hoop. A cloth stretched across the hoop would represent the plane or flat surface in which the earth moves around the sun. A little stick stuck through the edge of the hoop and tipped 23½° from the vertical would stand for the earth's axis. Because of this tipping, the two tropics—Cancer, or Crab, in the northern hemisphere, and Capricorn, or Goat, in the southern hemisphere—are 23½° from the

equator. In the same way the two polar circles—the Arctic Circle in the north and the Antarctic Circle in the south—are 23½° from the poles.

Latitude, Longitude, and Time

The Meaning of Latitude and Longitude. Although latitude and longitude are familiar terms, many people confuse them. Their relation to the globular form and rotation of the earth may be illustrated by an unusually high umbrella, shaped like a dome. The handle represents the earth's axis upon which rotation takes place. Its point sticks out at the pole, while the lower edge of the cloth, if it were straight instead of scalloped, would represent the equator. The ribs represent meridians by which longitude, or angular distance east or west, is measured. Circles parallel to the umbrella's lower edge would correspond to the parallels by which latitude, or angular distance north or south, is measured. If a rib were marked to serve as the prime meridian—the one, that is, on which is located the Greenwich Observatory near London—the position of any point on the umbrella could be indicated as so many degrees of longitude east or west of the prime meridian and so many degrees of latitude north or south of the equator. These relationships, as they appear upon a globe, are shown in A29.



A—Latitude and Longitude on a Globe.

Although latitude represents angular distances it can readily be converted into distances in miles if the size of the globe is known. The length of a degree of latitude is everywhere about 69 miles. Hence a mere glance at the distance between the parallels of latitude on a map tells one the approximate scale. A degree of longitude, however, has essentially this same length only at the equator. Elsewhere the length decreases steadily until it becomes nothing at the poles where all the meridians converge.

The distinction between longitude and latitude can easily be remembered by bearing in mind that longitude not only runs to 180°, but is the *long* dimension of the Mediterranean Sea where the terms were first used. Latitude runs only to 90°. The word comes from the Latin for "wide," meaning the width of the Mediterranean.

Another point to remember is that high latitudes not only are designated by high numbers both north and south of the equator, but also are those which would be highest on the umbrella of our illustration. The continent of Antarctica is in high latitudes, while Ecuador, which means

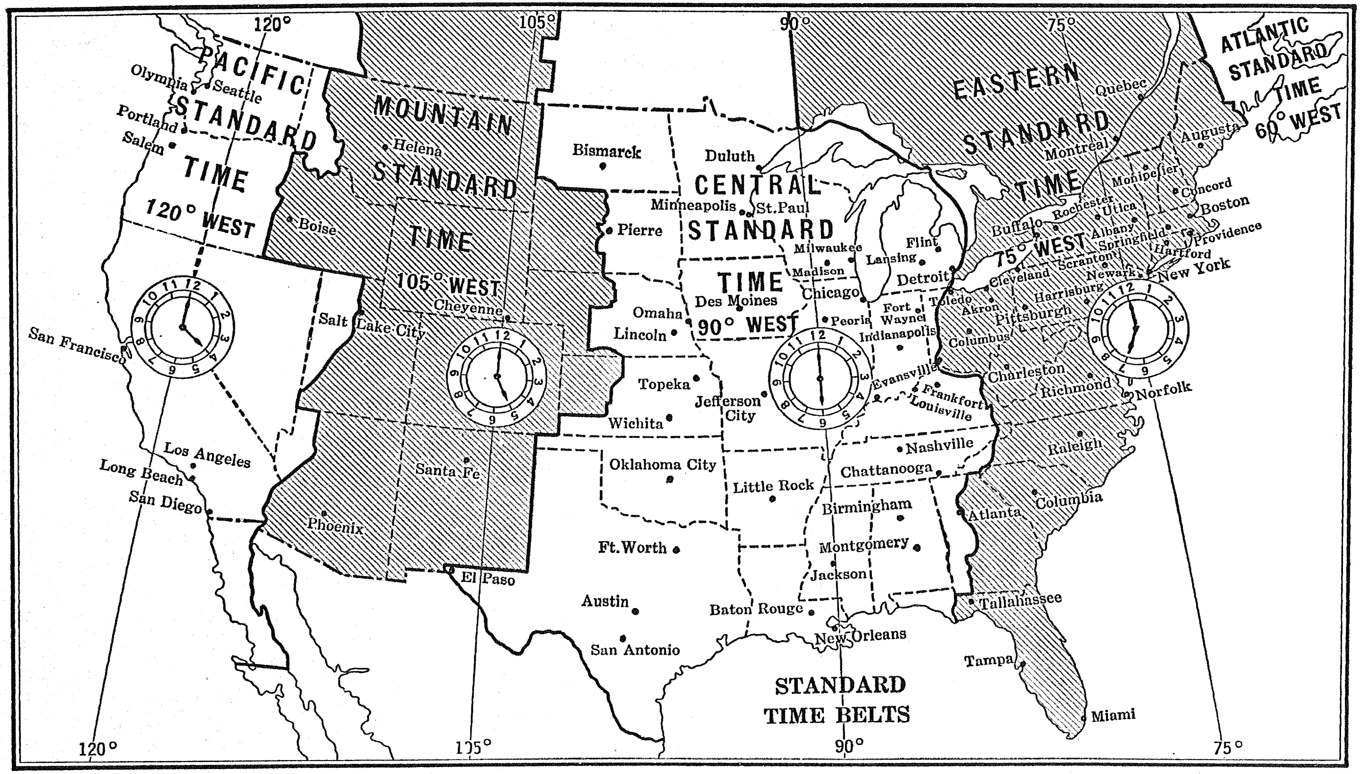
Equator Country, is in low latitudes. Our own country is in the middle latitudes, which are the best parts of the world.

A good example of the use of latitude and longitude is the way it enables ships and airplanes to determine their exact position. Hundreds of lives have been saved because ships and planes have been able to tell exactly where they were when accidents occurred. One of the earliest and most famous cases of this kind occurred in 1912 when the *Titanic* ran into an iceberg and sent out a wireless message that it was in 41° 46′ N. latitude, 50° 14′ W. longitude. Instantly the ships receiving the message hastened to the exact spot, even though it was far beyond their vision, and 711 lives were saved.

How Time is Determined. The movements of the earth, moon, and planets provide practically the only means of measuring time. Think how different life would be if there were no such thing as the year, month, and day, or even if we had no way of knowing the hour of the day. How could people meet at the right place for business, study, or recreation without wasting hours because some came early and some late? How could trains maintain any kind of schedule? Of what use would the radio be if no one knew when a program would be put on? The exact measurement of time is one of the primary foundations of a high civilization.

The sun is the natural timekeeper for all the world. When people first made careful measurements of time they based their reckoning on the hour at which the shadow cast by the sun is shortest. This gave the simplest form of "local" time, but the days measured in this way vary in length, owing to the varying speed of the earth in its elliptical orbit. By making corrections on this basis, we obtain what is called local "mean" time, according to which twelve o'clock is the *average* time at which the noonday sun reaches its highest point throughout the year. Local mean time, however, is not convenient in these days of railroads, automobiles, airplanes, and rapid travel, for in no two places is it the same unless the places happen to be on the same meridian. The first railroads were short local affairs, and each used the time of its chief city. Thus where several railroads met there were often several systems of time. In one town *five* systems were in use as late as 1880, and in the United States as a whole the railroads ran on 53.

To obviate this confusion the present system of "standard" time is based on longitude. Since the earth rotates 15° an hour, the railroads in 1883 agreed to use only the local time of meridians that are multiples of 15°. The United States is divided into belts lying on each side of these meridians, as appears in A31. This system is very convenient, for people do not need to change their watches except on passing from one belt to



A—Time Belts in the United States and Canada.

The clocks indicate the hour (A.M.) when it is 12:00 o'clock noon at longitude 0°, that is, on the meridian passing through Greenwich, England. Cities on the line between belts use the time of the belt east of them.

another, and then the change is always exactly one hour. As the railroads prefer to change time at division points where new trains are made up, rather than in the middle of long runs, the belts in A31 are irregular in shape. The telegraph, telephone, and radio sometimes cause people to use the time of some other belt than their own. The Stock Exchange in Chicago, for example, finds it convenient to be open at just the same hours as the far greater New York Stock Exchange.

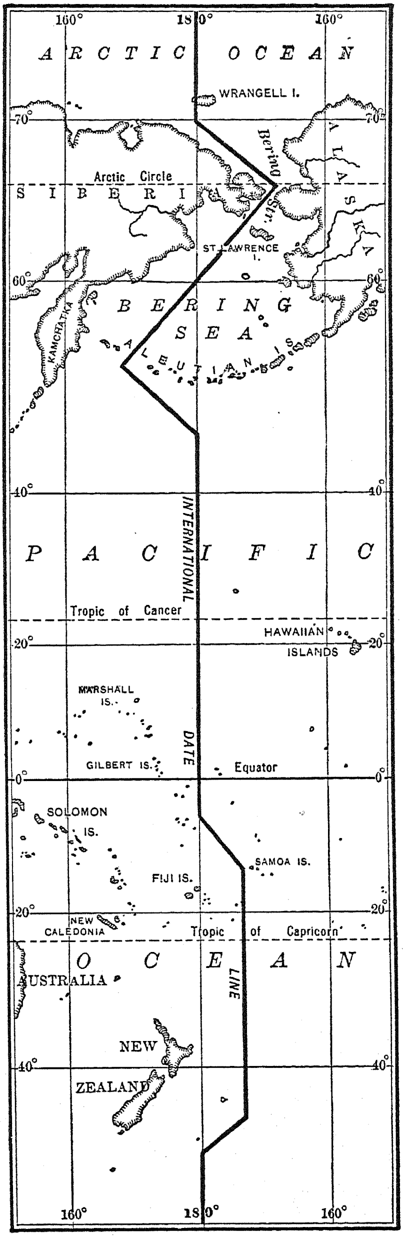
How Travelers Gain or Lose Time. On a journey around the world a traveler seems to gain or lose exactly twenty-four hours of time. For example, in 1519 the explorer, Magellan, left Spain with five ships to make the first voyage round the world. When his sole surviving vessel reached Spain three years later the crew could not understand why their reckonings made the date September 6, while the people at home said it was September 7. No mistake could be found in the ship's records, and the travelers were much puzzled until Paoli Sarpi told them that during their adventurous voyage they had lost a day by going around the world with the sun. If they had gone eastward, they would have gained a day, and would have recorded the date of their return as September 8.

The explanation is simple. Suppose that a traveler leaves London Monday noon, and travels westward 15° each day. Since 15° of longitude is equal to an hour of time, the sun at the second noon will reach the zenith an hour later than at London. Therefore at noon by the sun on Tuesday, the traveler's watch will say 1 P.M. He will set it back an hour, and his day will have been twenty-five hours long instead of twenty-four. If he keeps on around the world he will traverse 360° of longitude, and change his time twenty-four hours. Whether he travels slowly or rapidly the amount of time required for the sun to catch up with him will be the same for any given number of degrees, and when he gets back to London he will seem to have lost a whole day. In order to make his calendar like that of the people at home he must drop one date, just as Magellan's men dropped September 7.

In traveling eastward the days are shortened instead of lengthened, and the watch must be set ahead instead of back. The interval from one noon to another is less than twenty-four hours, and the days pass more rapidly than at home. So when the traveler reaches home his reckoning will be one day ahead of that of the people there. He must set his calendar one day back, and repeat one date.

Where Dates Are Changed. Whichever way one travels around the world the date must evidently be changed somewhere. If each person changed when he finished his journey, it would cause great confusion. The easiest place to change the day is the 180th meridian, for this lies

almost wholly in the ocean, and comparatively few people cross it. For convenience the actual *International Date Line* is a little zigzag, as shown in A33, for the Fiji and Chatham Islands prefer to have the same day as New Zealand, while the Aleutian Islands wish to be like the rest of Alaska. Whenever a ship crosses this line it adjusts its time, that is, drops the next day of the calendar if bound westward or adds a day, usually called Meridian Day, if bound eastward. Perhaps the only unhappy result of this arrangement is to the child whose birthday or Christmas falls on a lost day.



A—The International Date Line.

The Tides

There is an old saying that "time and tide wait for no man." Although the people who first said this may not have known it, the tides and our methods of measuring time both arise from the same condition, namely the rotation of the earth on its axis. At the seashore the tides give rise to some of the most interesting experiences. At low tide great stretches of oozy mud flats invite barefooted clam diggers to wander over them with short-handled pitchforks. Elsewhere acres upon acres of sea grass growing in salt marshes lie flat on the ground; broad sandy beaches are strewn with stranded bits of seaweed, broken shells, and translucent, daintily tinted jellyfish; on more rugged coasts the rocks are carpeted with brownish seaweed. In the coves many of the smaller boats lie keeled

over where they have been left by the retreating water. A smell of decay burdens the air, but is not wholly unpleasant. Then the tide turns, and the water slowly rises. After three or four hours the mud flats and weedstrewn rocks are covered, the marsh-grass begins to stand erect in the water, fishermen with their nets embark in the boats which are now afloat, bathers appear on the sandy beaches, strong currents flow up the inlets where previously the water was flowing outward. The whole appearance of the shore suggests life and activity, which reaches a maximum at high tide. Then the sea seems to be brimming full, all signs of death and decay are hidden, and a strong, life-giving odor pervades the air.

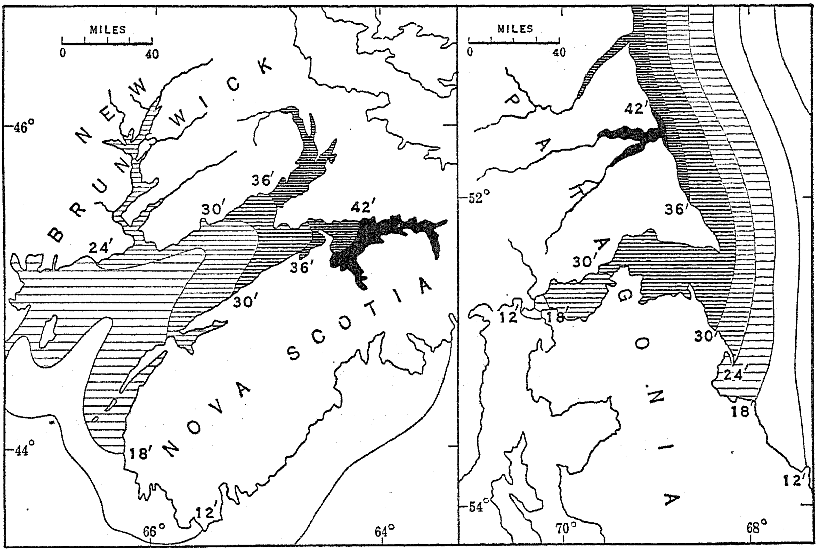
The Nature of Tides. The tides are great waves with a length from crest to crest equal to half the earth's circumference. As the wave approaches the shore and reaches shallow water, it behaves like the ordinary small waves seen in any body of water. Its speed decreases; the crest rises and the trough sinks, making the height greater. The height of the earth's tidal wave varies from 2 feet in the open ocean to 5 or 10 feet on ordinary shores. Where tides enter narrow bays the increase in height is sometimes impressive, reaching 50 feet at the head of the Bay of Fundy between Nova Scotia and New Brunswick. A35 illustrates the way in which the tide rises higher and higher as it moves headward in the Bay of Fundy and in Gallegos Bay on the coast of Patagonia. In the narrow bays where the shading of A35 is heaviest, many miles of mud flats are exposed at low water. When the tide returns it races across these almost in the form of a wall of foaming water, moving so fast that even a galloping horse would be overtaken and drowned. Very high tides present a serious problem in some of the world's greatest harbors, such as Liverpool, Bristol, and London. At the mouth of the Thames River below London the range between high and low tides is 20 feet. At such places basins with great gates have been built so that the water can be held uniformly at a high level and the ships will not move up and down against the wharves with every change in the tide. The gates are opened for ships to go out only near the time of high water.

Curiously enough, although the range of the tide is 20 feet at the mouth of the Thames, it is only 5 on the Dutch coast less than 100 miles away. This is because the waves of the tide enter the North Sea from two directions—through the English Channel on the south and around Scotland on the north. The tides coming in the two directions move at such rates that in some places they reinforce one another, but elsewhere neutralize one another.

Sometimes a tidal wave forms breakers in the same way as an ordinary wave. This occurs where the tidal wave forces its way into a narrow opening such as the mouth of a river. In the northern mouth of the

Amazon River such a tidal bore, as it is called, rushes up the river at the rate of 10 or 15 miles an hour in the form of a breaking, foaming, splashing wall of water 5 to 12 feet high. No small boat can live in it, and a steamship is endangered.

Kinds of Tides. The habits of tides in different parts of the world are far from uniform. The largest ocean, the Pacific, has two unequal tides. A narrower ocean, the Atlantic has two nearly equal tides each day at an average interval of about 12 hours and 25 minutes. Partially enclosed seas, such as those hemmed in by the East and West Indies, together with the Gulf of Mexico and the east side of the Sea of Japan,



By Courtesy of Geographical Review

A—Two Examples of Remarkably High Tides.

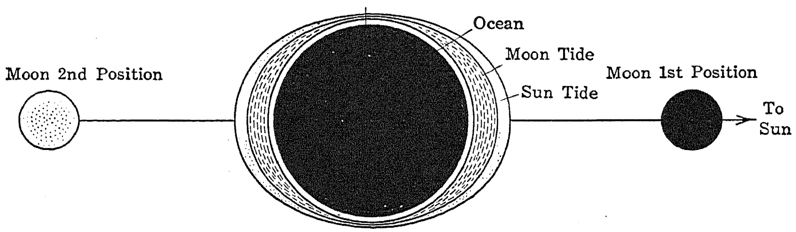
Bay of Fundy (left) and Gallegos Bay in Argentina (right). Numbers indicate height of tide in feet.

have only one tide a day. Seas such as the Mediterranean, Baltic, and parts of the Caribbean, as well as the enclosed Arctic Ocean, are practically tideless, or at least have tides that rise and fall less than 2 feet.

How the Moon Causes Tides. Tides are caused by the attraction of the moon and sun. They occur at regular intervals because of the rotation of the earth and the revolution of the moon around the earth. A water surface always places itself at right angles to the pull of gravitation. Since the moon as well as the earth exerts a gravitational pull, the surface of the ocean or of any other body of water must place itself at right angles to the combined strong pull of the earth and weak pull of the moon.

But the strength and direction of the moon's gravitational pull keep changing, because the earth's rotation, as well as the moon's own revolution around the earth, introduce constant and regular variations. The result is an extremely complicated series of tidal waves moving in all directions according to the part of the ocean which one happens to observe. Often a tide lags many hours behind the condition of the moon which causes it. In deep bays there may even be two tides at the same time. For example, as a tidal wave progresses up Chesapeake Bay from Old Point Comfort the shallowness of the bay hinders it so much that, by the time it reaches the head of the bay north of Baltimore, a second tide has entered the lower part of the bay.

How the Sun Modifies the Tides. The sun causes tides like those of the moon, but in most places not so high. The usual way in which sun tides become apparent is by increasing or decreasing the lunar tides. When moon, earth, and sun are in a straight line at full moon or new

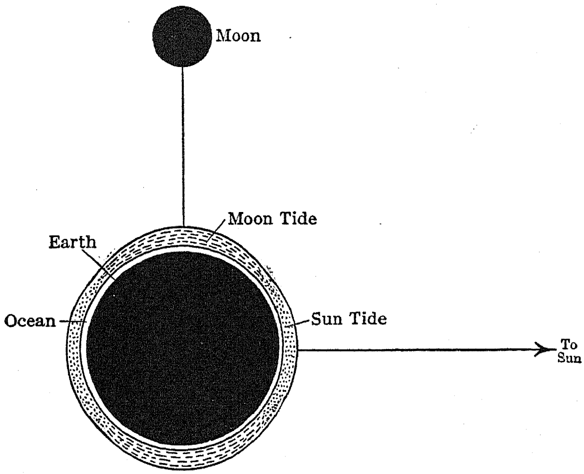


A—The Cause of Spring Tides. Moon and sun act together.

moon (A36) the two tides combine so that the high tides are higher than usual and the low tides lower. These are *spring* tides. When the sun and moon are at right angles to one another as seen from the earth (A37), they partially counteract one another so that *neap* tides neither rise so high nor fall so low as ordinary tides. It should be noted that, while the high tides are shown exactly under the sun and moon in A36 and A37, they are actually as much as 90° away in many cases because a lag is usually in evidence. At Bangkok in Thailand (Siam), where the harbor bar has only 13 feet of water at the ordinary high tide, a large ship may have to wait some days if it arrives at neap tide. The exact time of occurrence of either spring or neap tides varies from place to place, and in some regions may be as much as five days before or after the combination of lunar and solar activity which causes it.

The Construction of Tide Tables. The chief practical application of our knowledge of how the moon and sun influence tides lies in the construction of tide and current tables. These depend not only on the

relative positions of the sun and moon but also on the variations in the height of these bodies above the horizon at noon in different seasons. These cause such complex relations that they require laborious calculations which are now performed by means of machines. These sum up all the different effects and determine for years in advance how high the normal tide will be in any given place at any given time. The tides have to be separately computed for each port. Those at nearby places can be roughly deduced from those at the principal ports. The alterations in the usual course of the tides because of storms and winds, however, cannot readily be predicted. At London, for example, a storm with east winds has been known to make the tide 5 feet higher than was predicted.



A—The Cause of Neap Tides. Moon and sun act at right angles.

How Tides Improve Harbors. Tides have an important effect upon harbors. Many ship channels such as those of New York, Boston, and Liverpool are kept from silting up by the tidal currents which scour them out daily. In many cases where it has not been worth while to dredge channels the tidal channels enable ships to enter harbors which would otherwise be inaccessible. Off the mouth of most rivers there is a narrow zone where the sediment brought by the river is largely deposited, forming bars. The depth of the channel where the tidal water flows out over the bar is just enough to allow the water from the river to pass over it at all times. Where there are tides, the depth of the channel at low water is the same as it would be at all times if there were no tides, while at high water the depth is correspondingly greater. Thus harbors such as Bangkok in Thailand, and Liverpool in its natural

state, which would not be deep enough if there were no tides, admit ocean liners because of the depth at high tide.

Revolution of the Earth around the Sun

Human Habits and Length of Daylight. The earth's yearly revolution around the sun makes a difference to mankind mainly because the axis on which the earth rotates is inclined to the plane of the earth's orbit, and thus causes *seasons.* The inclination of the earth's axis causes the sun to remain above the horizon far longer in some places and at certain seasons than at others. Hence daylight and night vary greatly in length. This influences a multitude of human habits, such as the hours at which people rise, take their meals, go to work, or enjoy recreation. In summer people generally get up earlier than in winter. In middle latitudes many places adopt "daylight time." This habit would be of little value either in high latitudes where the summer days are excessively long, or in low latitudes where the length of the days varies only a little. In places such as Norway or Alaska, where daylight lasts long in summer, newcomers may become so tired and nervous from lack of sleep that they are often irritable. The long winter nights, on the other hand, bring with them a period of comparative idleness which also has a bad effect. There really is little or nothing to do.

The relative length of daylight and night has also an important bearing on temperature, and thus on plants and agriculture. In high latitude the earth and air become very cold during the long winter nights. If snow falls, practically none melts during the short days. It may accumulate so that even the long days of summer cannot melt all of it, and hence no crops can be grown. On the other hand, where little of the summer's heat is used up in melting the snow, the long days cause the air to become warm in spite of the low position of the sun. Hence in Siberia and Canada grain and vegetables can be raised as far north as the Arctic Circle. Sometimes steady growth throughout most of the twenty-four hours causes the yield per acre of crops such as potatoes to be enormous.

Effect of Length of Daylight on Production of Seeds. Another remarkable effect of the length of daylight is seen in the production of seeds. For many species of plants a certain definite duration of daylight is necessary if flowers and seeds are to be produced. In such cases, although temperature, moisture, and the intensity of light all have a marked effect on the size, shape, and vigor of the stems and leaves, they do not have much effect on the time of flowering. This depends almost wholly on the length of the period of light. For example, a new variety of tobacco called Maryland Mammoth was known to be valuable because

it grows to great size, sometimes 12 to 15 feet high. It was hard to raise, however, because no matter how early it was planted it would not produce seeds except when transplanted to a greenhouse during the winter. Then it was found that plants started in the autumn and only 1 or 2 feet high produced seeds at the same time as great stalks that had been growing since spring. Finally experiments showed that, if the tobacco were covered so that no light reached it during part of each day in summer, it would produce seed without regard to its size. In other words a healthy plant begins to produce seeds when the length of the period of daylight is reduced for a few weeks to eight or nine hours.

Other plants, such as the radish, usually blossom only when the period of light is long. For that reason many of the common vegetables of the temperate zone will not produce seeds in the tropics, for there the daylight never lasts much more than twelve hours. On the other hand, when such plants are grown in a greenhouse during the short days of winter, they can be made to blossom by subjecting them to electric light during part of the night. Chrysanthemums blossom only when the days become short in the late fall. For that reason they are able to stand considerable frost.

Many kinds of trees that blossom early in the spring are stimulated to form flower buds by the short days of the autumn. Cold weather comes on, however, and checks their growth, but as soon as the air is sufficiently warm they blossom during the short days of spring.

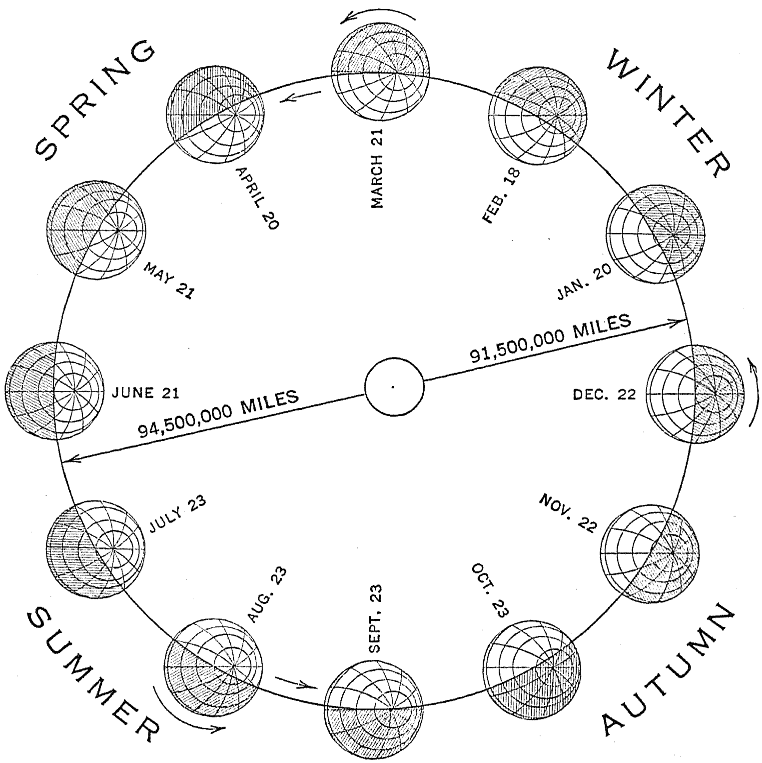
All this is important to the farmer. If he wants his crops to blossom quickly without making much growth of stem and leaf, he should plant them only a little before the time when the length of the days causes the flower buds to develop. If he wants much vegetative growth, however, he must plant long before the time when the length of the day leads to flowering.

How Daylight and Night Vary in Length. The cause of variations in the length of daylight and night is illustrated in A40. This represents the distribution of sunlight in the northern hemisphere during each month of the year. The proportions of the earth, sun, and orbit are far from true, but this is necessary in order to show the earth large enough. In the figure the North Pole is toward us, and the earth is revolving around the sun in the direction shown by the dates and inner arrows. It rotates in the same direction, that is counterclockwise, as shown by the outer arrows.

At the spring equinox, March 21, as appears at the top of A40 in the uppermost of the little globes, the sunlight barely reaches the North Pole. Hence at the pole the sun is seen on the horizon. There it remains throughout the twenty-four hours, swinging around the horizon through

360°, but not seeming to rise higher or sink lower. Except at the poles all parts of the earth at this date have a day and night of equal length. Therefore this date is called the spring equinox, for the name means "equal night." There is also an autumn equinox about September 22.

Now look at the diagrams for April, May, and June. At the pole the sun is considerably above the horizon. In spite of the earth's rotation, it remains visible at all times, so that there is no night. Day after day



A—The Seasons and the Length of Day and Night in the Northern Hemisphere.

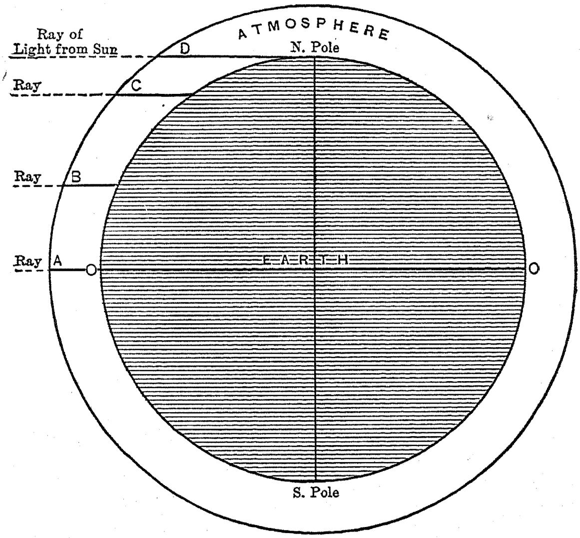
it stands at a slowly increasing height. If its path were traced in the heavens it would form a flat spiral mounting slowly upward until it reaches its highest point about June 21. Then the sun ceases to rise in the heavens and seems to stand still before it begins to descend. Hence June 21 is called the *solstice*, or standing still of the sun.

Let us work out the length of the days at different latitudes and seasons. On July 23 five-sixths of the Arctic Circle is in the sunlight at any one moment. Therefore a miner at the great bend of the Yukon sees the

sun five-sixths of the time, or about twenty hours. During the night of four hours the sun is so little below the horizon that there is light enough for work all the time. During so brief a night the earth has little chance to cool off. Hence even in high latitudes the mid-summer days may be warm and even uncomfortably hot if there is no ice or snow to be melted. That is why lichens, flowers, and grass grow luxuriantly at some places more than 70° from the equator. Let us next see how day and night would compare on July 23 at St. Paul in latitude 45°. In the July diagram in A40 approximately four and a half out of the twelve divisions into which the meridians divide the 45th parallel are in the darkness. As each division represents 30° of longitude the dark part of the circle contains about 135° and the light part 225°. As 15° of longitude equal one hour of time, the night lasts nine hours, and the day fifteen.

The Cause of the Seasons

(1) *The Relative Length of Day and Night.* The seasons play so overwhelming a part in our lives that it is interesting to understand their causes. The difference between summer and winter is due to four chief

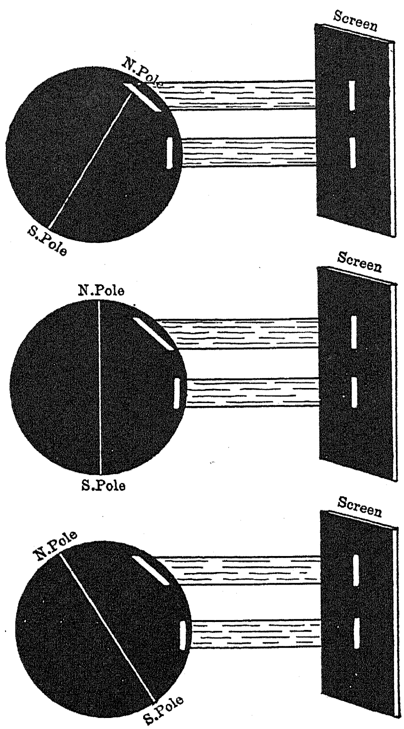


A—Effect of the Atmosphere on the Strength of Sunlight.

causes. The three most important depend upon particular ways in which the inclination of the earth's axis exerts an influence. One cause is the relative length of day and night. Even if all other conditions were the same, it is obvious that places where the sun shines three hours and

twenty-one hours out of every twenty-four must have very different weather.

(2) *The Relative Distance Traversed by the Sun's Rays in the Atmosphere.* The second cause of the seasons is the degree to which the sun's heat is absorbed by the atmosphere. At sunrise or sunset, even on the hottest day, one can look directly at the sun without difficulty. At noon, however, this is impossible. The reason for the contrast is that the air itself intercepts much light and heat, while the dust and moisture contained in the air intercept still more. At sunrise or sunset the rays of light reach the eye only after passing through much more air than at noon, as may be seen in A41, where the solid horizontal line at *D* is three or four times as long as the one at *A*. Hence much less heat reaches the earth's surface when the sun is low. Since the sun never rises high in polar latitudes, such regions are generally cold at almost all seasons. Since the sun is low during part of the year in middle latitudes, and high at other times, such places have pronounced seasons of warm and cool weather. Where the sun is always high in equatorial latitudes, the weather is warm at all times and the seasons are not pronounced.



A—Effect of Latitude and of Tilting of the Earth's Axis on the Area Warmed by a Given Amount of Sunlight.

(3) *The Varying Slant of the Sun's Noonday Rays.* A third important reason for the difference of the seasons is illustrated in A42. The middle globe shows the earth at the equinoxes, March 21 and September 23. The sun, which is far away to the right, is so situated that its rays are vertical at the equator. Between the sun and the earth has been placed a screen with two rectangular holes of the same size. The same amount of sunlight falls through each and warms a spot on the earth's surface. The spot at the equator, however, is much smaller than the one between 50° and 60° farther north. This difference in size is due to the fact that at

the equator the rays fall vertically, and hence cover the smallest possible space, while toward the poles they fall aslant and in this particular latitude are spread over an area twice as large as at the equator. Since the amount of heat is the same in both cases, a square mile, for instance, must receive twice as much heat at the equator as a square mile in the other position. This simple illustration shows that the sun gives most heat where its rays are vertical and least where they are most slanting.

The upper globe in A42 shows the conditions at the June solstice. Since the sun's rays are then vertical at the Tropic of Cancer, the sun rides high in the heavens in the United States, and a given amount of light and heat is concentrated in a relatively small area. In our winter, on the contrary, the sun is vertical at the Tropic of Capricorn, 47° south of the summer position, as the lower globe shows. Therefore, in all parts of the United States the light falls at a considerable slant, a given quantity is spread over a larger area than in summer, and the heating effect is less.

(4) *The Varying Distance of the Earth from the Sun.* The effects of these three causes of differences between summer and winter are slightly modified by the varying distance of the earth from the sun. In January the earth is about 3,000,000 miles nearer the sun than in July—91,342,000 miles instead of 94,452,000. Hence this period is called *perihelion,* which means "near the sun," while July is called *aphelion,* or "far from the sun." These conditions make the winters in the northern hemisphere slightly warmer than they would otherwise be, and the summers correspondingly cooler. In the southern hemisphere, on the other hand, the seasons instead of being tempered are made slightly more extreme. In that hemisphere the earth's varying distance from the sun causes the winters to be a little colder and the summers warmer than they would be otherwise.

Responses to the Seasons

Plants and Animals. In the whole realm of nature few conditions of environment equal the seasons in their effect upon life. One of the most obvious results is the revival of vegetation in the spring and its return to a barren state of dormancy in winter. It is hard to realize the marvelous quality of this change until one lives where there is almost complete uniformity at all seasons as in dry deserts, polar regions, high mountains, and damp tropical forests. Equally marvelous and almost more important is the effect of the seasons upon the production of seeds, fruits, tubers, and practically all the devices by which plants store up either food or water. Without these storage organs man and many animals, ranging from the bear and squirrel to birds, insects, and worms, would be unable to find food.

All sorts of grains, nuts, root crops, and fruits owe their origin primarily to the necessity of storing up food during one season so that the plant may have something upon which to make a start when a period of unfavorable weather is ended and the season of growth has come. In the parts of the torrid zone where there is plenty of moisture at all seasons, edible seeds and fruits are rare, and man is correspondingly handicapped in his search for food. In such places the plants grow so fast that many of them can easily reproduce themselves by mere spores such as those of the fern, or by the vegetative growth of shoots as in the banyan, banana, and mangrove. In the oceans, where the contrast between one season and another is reduced to slight proportions, no seed plants have ever been evolved. What few there are have come back to the water from the land. It is enough for the water plant to send out spores—mere unclothed cells. They do not have to endure the rigors of a long cold or dry season. Nor is it necessary that they grow as fast as possible in order to make the most of the time when the weather is favorable. Hence it is not necessary that a small plant be packed away with its main organs already developed. Nor is a store of food needed to insure it a good start. This seems to be one of the main reasons why the plant life of the ocean has remained at a low level, while that of the lands through the stimulus of variety, and especially of the seasons, has become highly diverse and progressive.

Among animals the effect of the seasons is as marked as among plants. The hibernation of bears, rodents, and insects, the migrations of birds and fish, the growth and shedding of winter hair or fur, the molting of birds, and the putting on of fat at the approach of winter are all responses to the change of seasons. These and similar changes have much importance for man. Wool, fur, lard, and bacon fat are articles which the animals produce seasonally in order to protect themselves from the winter. In warm countries sheep's wool becomes hair, and the hogs are lean.

The fact that warm-blooded animals, that is, birds and mammals, are found almost wholly on the lands and are air breathers, even when in the water, appears to be partly due to the seasons. When animals first came out of the water and lived on the land millions of years ago, a great advantage, presumably, was reaped by those able to warm themselves a little and thus continue their activities in cold weather. Warm blood involves a higher rate of activity than cold blood. It thus puts a great premium on intelligence and on the development of the higher qualities such as parental care and love for offspring. The cold-blooded animals practically never care for their eggs or young. They do not need to. Among warm-blooded animals, however, if there are cold seasons, the eggs must be kept warm and the young must be protected from bad

weather. This was apparently one of the primary reasons why the parents took an interest in their young. Little by little the swing of the seasons selected for preservation the types of animals that had these new and higher instincts. This gave a peculiarly good chance for natural selection to preserve those whose brains were most highly developed. Thus along with the parental instinct the development of intelligence was fostered by the seasons.

All this meant that the young animals became more and more dependent upon the mothers. Hence when types that placed the young in pouches were developed in addition to those that merely laid eggs, they had an advantage in the struggle for existence because the young could be protected not only from enemies but from the inclement weather as well. The last step was the evolution of true mammals whose helpless young are born alive. Their evolution, so far as we can tell, took place chiefly in the great continental interiors where the contrasts of the seasons are greatest, and where the rigors of winter are among the most powerful factors in eliminating many types and preserving those whose intelligence is relatively high.

In the oceans nothing of this sort has taken place, for there the almost complete uniformity from season to season has not favored the evolution of the higher types. When the higher types go back to the monotony of the oceans, as the whale has done, the lack of seasonal stimulus joins with the uniformity of the environment in other respects in causing them to lose their higher capacities. Thus the seasons have much to do with the fact that the oceans are the home of low, cold-blooded forms of animals as well as of low, spore-bearing types of plants, while the lands, especially those parts with strong seasonal contrasts, are the home of the highly developed mammals, birds, and seed-bearing plants.

Physiological Reactions of Man to the Seasons. Among men the influence of the seasons is no less than among plants and animals. One of the best-known effects is variation in health from season to season. In climates such as those of the northern United States and western Europe the deathrate is systematically lowest at the end of summer and highest late in the winter. Certain diseases, however, such as digestive troubles, show an opposite variation, being most numerous and most likely to be fatal in summer. Births also vary in number according to the seasons. In the most densely populated parts of the United States they are most numerous in the early spring and again in the late summer. In western Europe there is a strong and widespread tendency toward a maximum in the early spring. In other climates both deaths and births show a different adjustment to the seasons according to the temperature. Everywhere, however, human beings respond to the seasons in essentially

the same way as plants and animals except that man has learned how to overcome many effects of the weather, but by no means all.

Response of Human Activities to the Seasons. The majority of human activities show some variation according to the seasons. With farming this is preeminently true. A farmer who has few livestock—and there are millions of such—has practically nothing to do during the winter. If snow lies on the ground or the soil is frozen, time often hangs heavy on his hands. Such inactivity of the men among a hundred and twenty million peasants in Russia is one of the greatest handicaps of that country. In the summer, on the other hand, in spite of the long days the farmer is busy every moment and his work often piles up ahead of him. With students and most people who are engaged in literary and scientific pursuits quite the opposite is true. In winter, when daylight is short, they often injure their eyes by poring over books from morning till midnight. In summer when the long days are best for study so far as light is concerned, although not necessarily otherwise, they frequently spend weeks or months with little or no study. Between the farmers and the students are people upon whom the seasons have almost every degree of effect. The railroad man, the manufacturer, the banker, the carpenter, and the hardware merchant all have busy seasons and slack seasons at regular times of the year. Moreover, the nature of their work varies from season to season. Health and recreation vary similarly, for people generally have the best health in the summer and autumn, while such games as hockey and football are rarely played except at certain seasons. The difficulty is not to find examples of seasonal variations, but to find occupations or activities upon which the seasons have no effect. And all these seasonal activities depend directly or indirectly upon the differences in weather arising from the inclination of the earth's axis.

How the Seasons Have Helped to Civilize Mankind. Without the seasons mankind might never have become civilized. When early man began to rely on his mind instead of on physical strength, one of his first important ideas was to store up food for seasons of scarcity. So far as he lived by hunting this was relatively unimportant, but if he gathered nuts it was important, and as soon as he relied mainly on farming he could not live unless he stored up food in summer to last him through the winter. In regions with strong seasonal changes this was far more necessary than in warm regions with no real winter or dry season. Moreover, the strong contrast between the seasons stimulates him not only to store up food, but also to make new inventions. In every stage of life those people are most successful who plan intelligently for the future which lies months or even years ahead of them. The inclination of the

earth's axis and the resultant seasons have been among the chief incentives to this kind of foresight.

Local Influences of Time and Season. Even within the limits of a single city or township people's responses to day and night or to the seasons vary from one locality to another. It would be possible to make a map of such an area showing that in some sections people go to work early and in others late. The hours of meals, shopping, recreation, and going to bed differ similarly according to whether a given section is inhabited mainly by day laborers, factory workers, clerks, or professional people. Another interesting variation is seen in the hours at which the most automobiles are in use and automobile accidents are most numerous. The theater district is crowded when the factory district is empty. The geographical distribution of the police varies from hour to hour, day to day, and season to season according to whether people are going to work, to school, to the stores for shopping, back to their homes, or to places of recreation. A map of occupied and unoccupied houses at different seasons shows wide variations, for in certain sections the houses are almost vacant in summer, whereas in others, such as the seashore or any kind of summer resort, they are empty in winter. Certain businesses and certain kinds of street corners are especially busy at certain seasons because they sell soft drinks and icecream, or do some other business that is more needed at one time of the year than another. The distribution of crime, accidents, crowds, police, and places of recreation within any given community varies greatly from summer to winter. So, too, does the number of hours worked by the average person per day. In a section inhabited by farmers, day laborers, carpenters, and masons the hours of work per week are far greater in summer than in winter. All these local variations and many others are parts of microgeography. Even when mapped only in very rough fashion they are most interesting.

QUESTIONS, EXERCISES, AND PROBLEMS *

1. A. On a globe follow your meridian southward until you are in a south latitude equal to your home latitude. How many degrees of longitude are you from South America, and how many miles? How does the time there compare with that at your own home and at Greenwich?

B. Find a place half way around the world in your own latitude. State its location in latitude and longitude.

C. State the exact location of your antipodes in terms of latitude and longitude, and find the place on the globe. How far and in what direction is this place from the nearest land? What is the hour of the day there while you are working out this exercise?

* As a rule it is not to be expected that every student should answer all these questions.

2. Locate the following points in respect to some country, island, or body of water:

A. The place having the lowest latitude and longitude.

B. The lowest latitude and the greatest longitude.

C. The highest south latitude and least longitude.

3. On a globe or world map locate all the places having a latitude of 45° and a longitude of 45°. What is their time when it is noon at Greenwich?

4. A. On March 22 a sea captain observes the noonday sun 55° south of his zenith. What is his latitude?

B. On June 21, what is the latitude of an observer if the noonday sun is seen 10° south of the zenith? If it is seen 10° north of the zenith? 47° north?

C. In what harbor is a ship located if on December 22 the captain observes the noonday sun 75° south of the zenith, and notes that the chronometer agrees with the local time?

D. What is the location of a vessel whose chronometer reads 9.40 A.M. at local noon, and whose captain observes the noonday sun 43° south of his zenith on September 22?

5. A. Pittsburgh, Pa., with a latitude of 40° 28′, and Charleston, S. C., with a latitude of 32° 48′, both lie on the 80° meridian. What is the distance in miles between the two cities?

B. Enumerate the countries you would cross in following your parallel eastward around the world.

C. Follow eastward the parallel in the southern hemisphere corresponding to your own in the northern, and list the countries that are crossed.

D. Similarly follow your meridian, starting southward, and list the countries that would be crossed in passing around the world.

6. How is it that an account of the last shots in the first World War was published in the morning papers of San Francisco although the firing did not stop till 11 A.M. of that day?

7. What kind of tides would there be in New England if on the full of the moon a vigorous northeast storm were in progress? Explain.

8. Give an illustration from your own observation or experience of the influence of seasons upon (1) food, (2) clothing, (3) shelter, and as many as possible of the other "human responses" listed in the last column of the table on page 4.

9. Why should southern New England favor the "daylight-saving plan" while northern New England prefers that clocks and watches should keep standard time the year round?

CHAPTER IV

MAPS AND MAP-MAKING

The Value of Maps

It is impossible to study geography intelligently without maps. The primary purpose of maps is to show location. Unless a map is at hand, it is perplexing to be told that a large city is located approximately 30° N and 90° W, or that it is about 140 miles southwest of Mobile. It is a little better to be told that the city lies on the east bank of the Mississippi, 107 miles from the river's mouth. It is vastly easier, however, to look at a map and see the relation of New Orleans not only to Mobile and the Mississippi River, but to hundreds of other rivers, towns, mountains, bays, gulfs, and other geographical features. Maps are useful because they show not only the *direction* and *distance* from one place to another but also the *size* and *shape* of any feature large enough to be fairly represented. In the United States the most nearly universal use of maps is for planning automobile trips, but there are many other uses. The traveler on foot or on horseback in the wilds of Africa, Central Asia, or the Amazon Basin, where there are no roads, may waste many days, or even lose his life because the maps are wrong. In wartime prisoners who are trying to escape make tiny copies of maps on their toenails, or hide them in the seams of their clothes, hoping thus to keep them out of sight of their guards. Even these inadequate maps have helped many prisoners to escape from Germany or other countries.

What Can Be Shown on Maps. Maps can be used for an enormous number of purposes. Their primary purpose is to show the location of (1) the physical features of the earth as listed in the first column on page 4, especially the land forms and bodies of water; (2) the distribution of living organisms, especially man, but including plants and animals; and (3) the distribution of all sorts of cultural features, that is, of human responses to geographic environment, as shown in the last columns on page 4. The most common kinds of maps show the relative location of natural features such as lakes, rivers, oceans, and mountains, and of cultural features such as cities, railroads, and political boundaries. Almost everyone, however, is familiar with other kinds of maps such as relief maps, which show land forms by means of shading, contour lines, or colors. Maps of minerals and soils are less common, but are used con-

stantly by mining men and agricultural experts. Climatic maps are very widely used. Each day the Weather Bureau gets out a map showing the atmospheric pressure, winds, temperature, cloudiness, and rainfall for the whole United States. By studying the weather map wide-awake superintendents of large heating plants save thousands of tons of coal. Many a mariner, fruit raiser, aviator, or shipper studies these maps with the greatest care. He knows that his profits, or even his life, may be destroyed if he reads the map incorrectly.

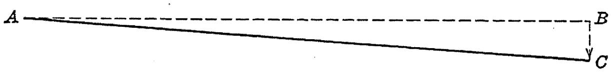
Other conditions, such as the distribution of plants or animals, can readily be put on maps, as can every one of the human responses in the list on page 4. Maps may show the location of fishing communities, for example, or of banana plantations, adobe houses, or regions where people wear wooden shoes. They may also show where people have much energy, where influenza is most common, where cotton goods are manufactured, where caravans are used most largely in transportation, where coal is an important article of commerce, where people are savages, where democratic forms of government prevail, where baseball is a favorite recreation, and where civilization is high.

How Maps Help in Explaining Geographical Distribution. In the preceding paragraph examples have been given of maps pertaining to each of the elements of geographical environment and many of the human responses as given on page 4. Notice that in every case something is said about *location,* or else the word *where* is used. These words furnish the key to the value of maps. But to know where anything is located is not enough; we must also know why. Many times we can determine this by comparing one map with another. Such comparisons are one of the most important features of human geography. Only by a comparison of maps showing density of population and amount of rainfall, for example, can we clearly understand how great a diminution of population results from too little or too much rain. Even the best maps, however, do not explain many of the most interesting responses of man to his geographical environment, and for these we must rely on observations of geographers, tables of statistics, and many other sources.

Practical Use of Latitude and Longitude

In making a map of any large area the first step is to determine the latitude and longitude of at least two points. The methods used by the surveyor in doing this are essentially the same as those used in the navigation of a ship by means of the sun and stars. The sea captain out of sight of land, or the aviator when he is over the ocean, has no beacon lights or visible signals to guide him. He cannot even measure the speed of his ship or airplane with perfect accuracy. A ship, to be sure, is equipped

with a log, or little wheel, that drags in the water far astern and measures the distance like the mileage indicator on an automobile. The mariner also knows how many revolutions the propeller makes and how far each is supposed to send the ship forward. The ship, however, may be retarded or set ahead by winds or ocean currents whose speed is not accurately known. Hence the "dead reckoning" based on the log and on estimates of the effect of wind and currents may be either less or more than the distance actually traveled. Moreover, the mariner cannot always be sure that his ship is moving in the right direction. Its prow may always point right, but an unusually strong current or wind may carry the vessel many miles from its true course in spite of the mariner's corrections, as appears in A51. Then, too, if the ship's compass is of the magnetic type, instead of the new gyroscopic type, this also is subject to unexpected fluctuations which may put the ship off its course. An airplane is subject to similar difficulties.



A—Position of a Ship by Dead Reckoning and by Observation.

A—*B*=Course by dead reckoning.
B—*C*=Unreckoned drift.
A—*C*=Actual course.

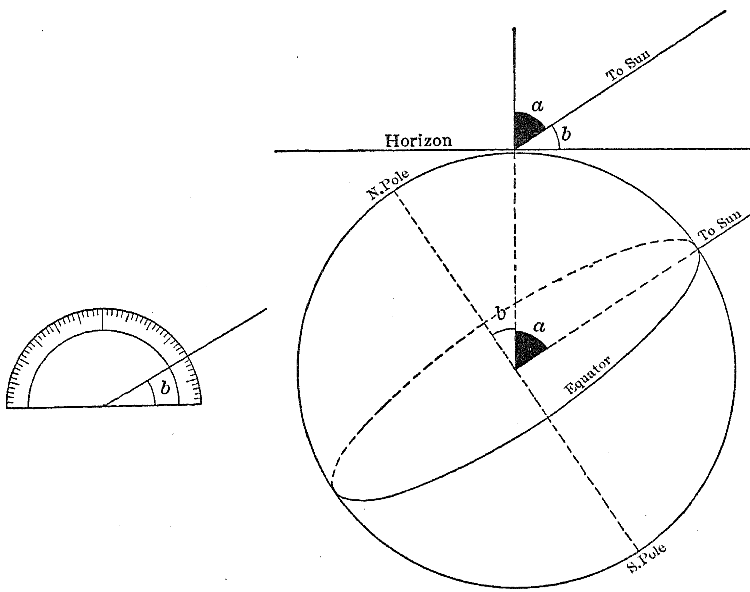
When the navigator approaches land, particularly in a fog, such mistakes are most hazardous. Hence he must be able to determine his latitude and longitude, and thereby correct any mistakes that he has made in his dead reckoning.

Latitude at Sea. Wherever one may be, the number of degrees from the zenith to the noonday sun is always equal to the number of degrees between the observer's position and the part of the earth where the sun's rays are then falling vertically. The *Nautical Almanac* * tells exactly where the rays are vertical at any given time. Hence the first thing is to measure the angle between the zenith and the noonday sun. This, however, cannot easily be done with a sextant or on a moving base like a ship, because the zenith is not a definitely marked point. The horizon, on the contrary, is very clearly marked at sea. Therefore, the mariner actually measures the distance from the horizon to the noonday sun. By subtracting this measurement from 90° he easily gets the angle between the sun and the zenith. By adding to or subtracting from this angle the number of degrees by which the sun is north or south of the

* The *American Ephemeris and Nautical Almanac* is to be obtained for a small fee from the Superintendent of Documents, Government Printing Office, Washington, D. C.

equator, as given in the *Nautical Almanac,* he obtains his latitude. (See A52.)

Longitude at Sea. While determining his latitude the mariner may determine the hour of local noon by finding the exact moment when the sun is highest. Knowing this he can determine his longitude by simply comparing local noon with Greenwich time which is always kept on ships by clocks of remarkable accuracy, called *chronometers.* In



A—Use of the Sextant.

The little diagram on the left shows a graduated circle on which the angle b has been measured. A sextant has a similar graduated arc on which the observer measures the angle between his horizon and the noonday sun. Such an angle is shown at b in the upper part of the main diagram. At the equinoxes, when the sun is vertical at the equator, the latitude of the place of observation is measured by either of the angles marked a, since the lines marked "to sun" are parallel. But the angle a is evidently equal to $90° - b$. Hence, to find the latitude at any time of the year it is merely necessary (1) to measure the angle b at noon with a sextant, (2) to subtract b from $90°$, and (3) to add or subtract the latitude where the sun's rays happen to fall vertically on the date in question as given in the *Nautical Almanac.*

practice he makes another observation for this earlier in the day. Ships now rely on electric clocks and radio to keep their time correct.

Since any place on the earth's surface rotates through 15° in one hour, there is a difference of 15° in longitude for every hour of difference between the mariner's local noon and the time indicated by the chronometer. Thus if local noon occurs when the chronometer reads 1 P.M., the ship is 15° from the prime meridian. Since local time is be-

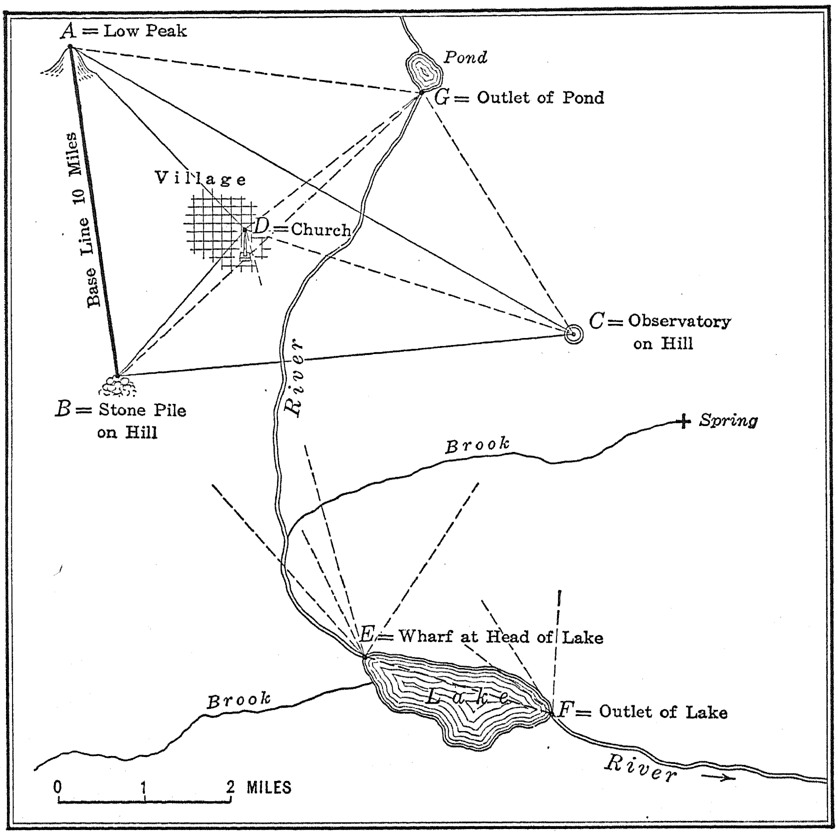
hind Greenwich time the ship is west of the prime meridian. Hence the longitude is 15° W. Suppose local noon comes at 9.40 A.M. by the chronometer. In this case local time is two hours and twenty minutes ahead of Greenwich time, which is equivalent to 35°. Hence the ship is east of the prime meridian, and the longitude is 35° E. When the mariner has determined both latitude and longitude, he knows exactly where he is, and can locate the spot on his chart of the sea on which he is sailing. An explorer in Central Africa with his sextant and chronometer can put a newly discovered town on the map with a high degree of accuracy in an hour.

How Maps Are Made

The method of making a map of a previously unmapped region is illustrated in A54. First the surveyor chooses two conspicuous points, like *A* and *B,* which are mutually visible from one another, and from which as wide a view as possible is seen. These he locates astronomically, that is, by observations of the sun or stars and of the chronometer. In doing this, he uses substantially the methods employed by the mariner. Next, he carefully measures the distance between his points of observation, thus getting a baseline (*A–B* in A54) from which he can determine other distances. Then he draws his two points and his baseline on a sheet of paper placed on a movable drawing board which is fitted to the head of a tripod. Setting up this plane table directly over the point *A,* he makes it horizontal. Then, with the help of a little movable telescope, he adjusts it so that the line *A–B* runs in exactly its true direction. With the further help of the telescope he draws lines directed toward various conspicuous objects such as the observatory *C,* the church *D,* and the wharf at the head of a lake, *E.* Moving now to *B* at the other end of the baseline, he repeats the process, drawing lines to as many as possible of the points already selected and to new ones not previously visible. The two lines directed toward the observatory meet at *C* in A54, and the two toward the church meet at *D.* Thus he knows that on his plane table map the observatory is located at the apex (*C*) of the triangle *A–B–C* of which the line *A–B* is the base, while the church is located at the apex of the corresponding triangle, *A–B–D*; and so on for *E, F,* and *G.* In this way many points are located by means of triangles. Hence this fundamental process in map-making is well called triangulation.

In actual practice the map-maker is rarely satisfied to locate a point at the apex of a single triangle. In A54, for example, he might go from *B* to *D* and once more set up his plane table so that the line *B–D* will be in exactly the right direction. Then he would draw lines to as many as possible of the points previously observed and complete a new set of

triangles. If the point *C* is exactly at the apex of the triangle *B–D–C,* as well as of *A–B–C,* the certainty that it is correct greatly increases. In general, the surveyor tries to get a number of bearings on each point, as at *E* and *F* near opposite ends of the lake in A54, thus making sure that his work is correct.



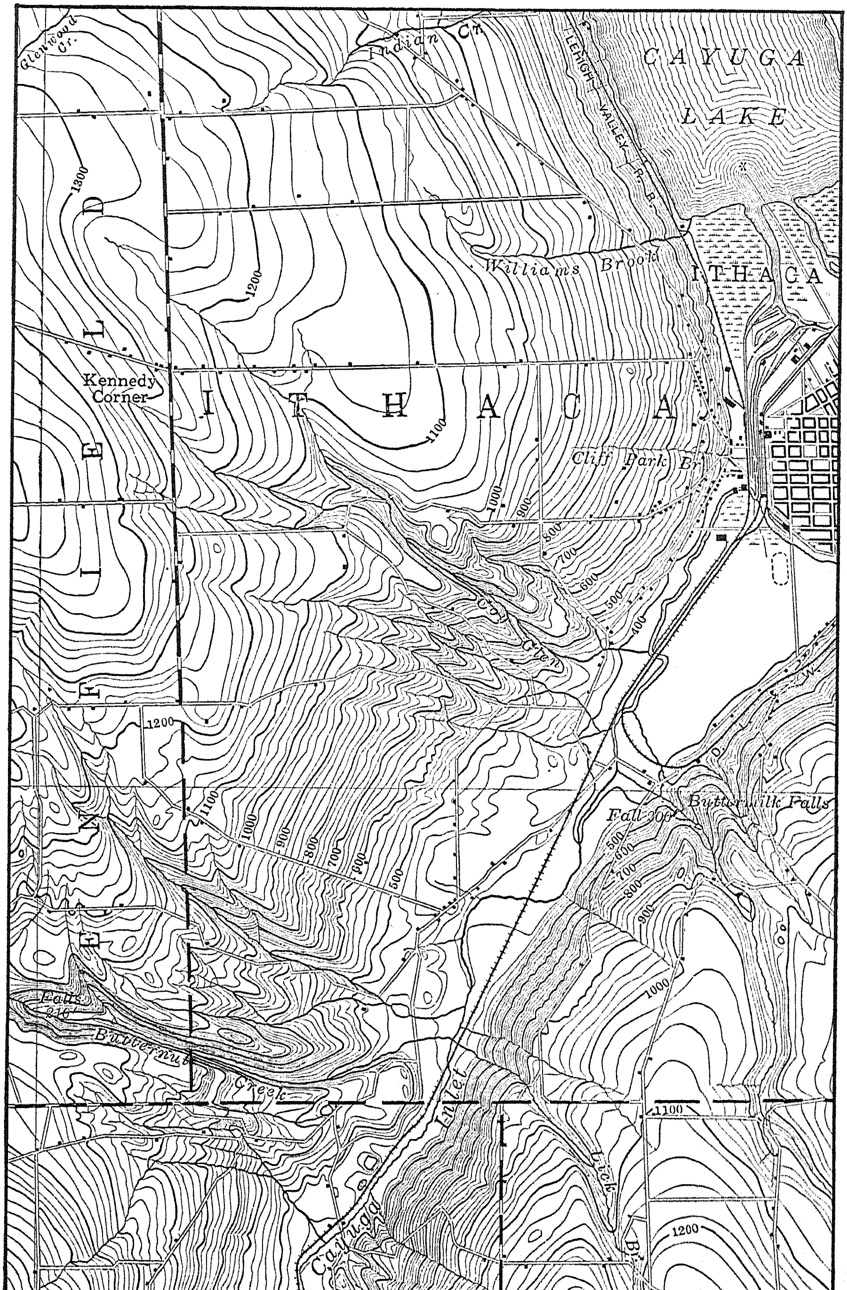
A—Method of Making a Map by Triangulation.

After the main triangulation the surveyor carries out minor triangulations, thus locating less important points. He also makes "traverses" by going along a road or river, measuring his distances roughly, and making frequent minor triangulations. In this way, he sketches in the minor details, unless his map is on a very large scale. In that case he may measure the exact location of every house and barn.

In addition to measuring horizontal distances, the map-maker must measure vertical distances—that is, the height or altitude of the various

places on his map. This is done roughly in new countries by means of an aneroid barometer, or by the boiling point of water. As one rises to higher elevations the pressure of the air diminishes, and water boils at a lower temperature. Such methods, however, are only temporary expedients. For final work, the altitude is determined by two processes. One is leveling, which corresponds to measuring a baseline. In this, the surveyor very carefully adjusts his telescope so that it is absolutely horizontal and, by means of a measuring rod held vertically at a distance ahead of him, finds just how much difference there is in the altitude of the ground where the instrument and the measuring rod are placed. By repeating this many times, and with great accuracy, the altitude of places far apart can be exactly determined. The other process is triangulation, like that already described except that the angles are measured vertically. They are generally so small that it is best to calculate the length of the vertical side of each triangle, instead of relying on drawings. After the altitude of many points has been determined, and written on the map, the surveyor, or topographer, as he is often called, draws contour lines like those in A56, which is close to Cornell University. If the country that is being mapped consists of hills a few hundred feet high, a contour interval of 20 feet may be adopted. If the zero contour line is at sealevel, that is, at the average level of high tide, the 20-foot contour indicates that all points through which it passes are 20 feet above sealevel. In the same way the 40-foot contour line passes only through places 40 feet above sealevel. Any place between these two lines has an altitude of more than 20 feet and less than 40. In A58 the hilltops south of San Francisco appear as places where sets of more or less concentric contour lines culminate in small circles or ellipses, the elevation of which is sometimes indicated. In A58 several such hilltops are cut in two by the borders of the map. A little practice in reading topographic maps, such as A56 and A58, makes it easy to understand not only the horizontal distribution of rivers, lakes, roads, cities, and so forth, but also the general form and height of hills and mountains in comparison with valleys or plains. Practice in this is important.

Airplane Mapping. Since the invention of airplanes a new method of making maps has been developed. This consists of taking photographs from the air. Sometimes several photographs are combined in such a way that they form both a picture and a map, but this can be done only for small areas. The general method is to take stereographic photographs. In other words, the airplane is fitted with two cameras, which are arranged so that they take pictures at the same instant. Then by means of complicated instruments it is possible to work out the distances and elevations of each part of the photograph. When a great many



A—Contour Map of Ithaca, N. Y.

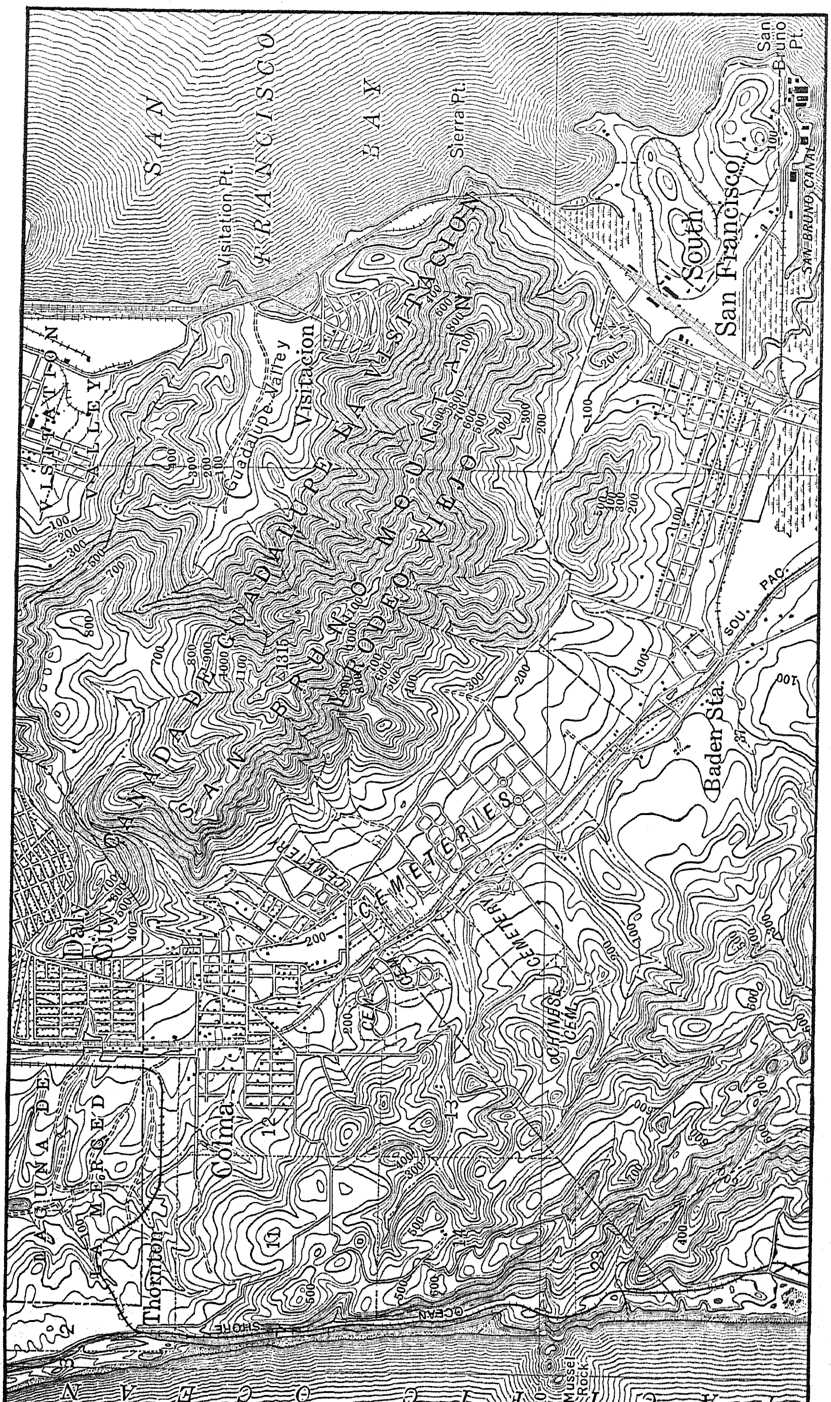
Contour interval, 20 feet. Scale, 1 : 62,500 or 1 inch equals 1 mile. Find examples of young gorges, deltaic plains, plateau-like areas of gentle relief, control of settlement by relief, places

overlapping photographs have thus been taken, it is possible to make an excellent map from the air. This is possible, however, only when a sufficient number of easily identified points have been located by the old method of triangulation. Otherwise the aerial photographs have nothing by which they can be exactly located. By means of such photographs a region can be mapped far more rapidly than in the old way. The photographs taken by a single airplane in one month are enough to keep a considerable number of cartographers (map-makers) busy for a year. This is a great advantage because it makes it possible to take the photographs at the most favorable time of the year. Aerial map-making is especially helpful in rugged and inaccessible regions.

Map Projections

If a large area is to be mapped, the curvature of the earth must be taken into account. When a map is originally made on a plane table it is constructed as if the earth were perfectly flat. This causes no difficulty at first, but as soon as a large area, such as a good-sized state or, still more, a country, continent, or hemisphere is mapped, the curvature of the earth's surface interposes a difficult problem. Such a curved surface cannot possibly be made flat, as is easily seen when one tries to flatten an orange skin without breaking it. This has led to many attempts to frame map projections, which represent the earth's surface with its meridians and parallels as accurately as possible. These all fail in one or more of the following respects: (1) the shapes of the regions represented are wrong; (2) the areas are wrong; (3) the distances are wrong; (4) in following any given direction, such as northeast, the line to be followed forms a curve instead of being straight.

The three primary types of projection shown in A59 will be briefly described in order to illustrate the methods and difficulties of making them. The first, or stereographic projection (1 in A59), is sometimes used for hemispheres. The map sheet touches the globe at the point where the equator crosses the central meridian of the hemisphere that is to be drawn. From the point on the equator directly opposite the point where the sheet touches the globe straight lines are drawn through all needed points in the hemisphere that lies next to the map sheet. These lines are prolonged beyond the globe until they hit the map sheet. The points where they hit are the bases of the final map. As a matter of fact the parallels and meridians for this projection, or any other, are drawn by geometrical principles so that actual juxtaposition of the map sheet and the globe is not necessary. Then the rest of the map is drawn according to the latitude and longitude of the points that are shown. The central part of a stereographic projection is in true proportion, and the forms of the

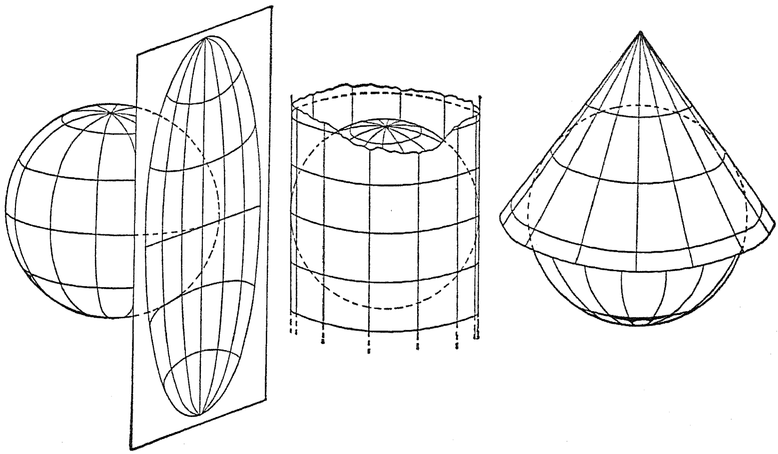


A—A Contour Map of South San Francisco.

Contour interval, 20 feet. Scale, 1 : 62,500, or one inch equals a mile. Find examples of steep wave-cut bluffs, location of railroads and houses in relation to topography, winding versus straight roads, areas remaining unoccupied because of rugged relief. Why does this map look so much darker than the one on page 56?

lands, lakes, and so forth are correct. On the edges the distances are doubled, and the forms become more and more distorted as one gets away from the center. Many other kinds of projections are also used in representing the earth as a whole, as appears, for example, in A60 and A64.

In the Mercator projection (2 in A59) a cylinder is supposed to be wrapped around the globe touching it everywhere at the equator. Lines are drawn from the center of the globe to the cylinder through the points which it is desired to locate. When such a cylinder is slit and laid flat, the whole earth appears as a single map with only one break between the hemispheres. Both meridians and parallels are straight lines. Hence a given point of the compass is always in the same direction on all parts

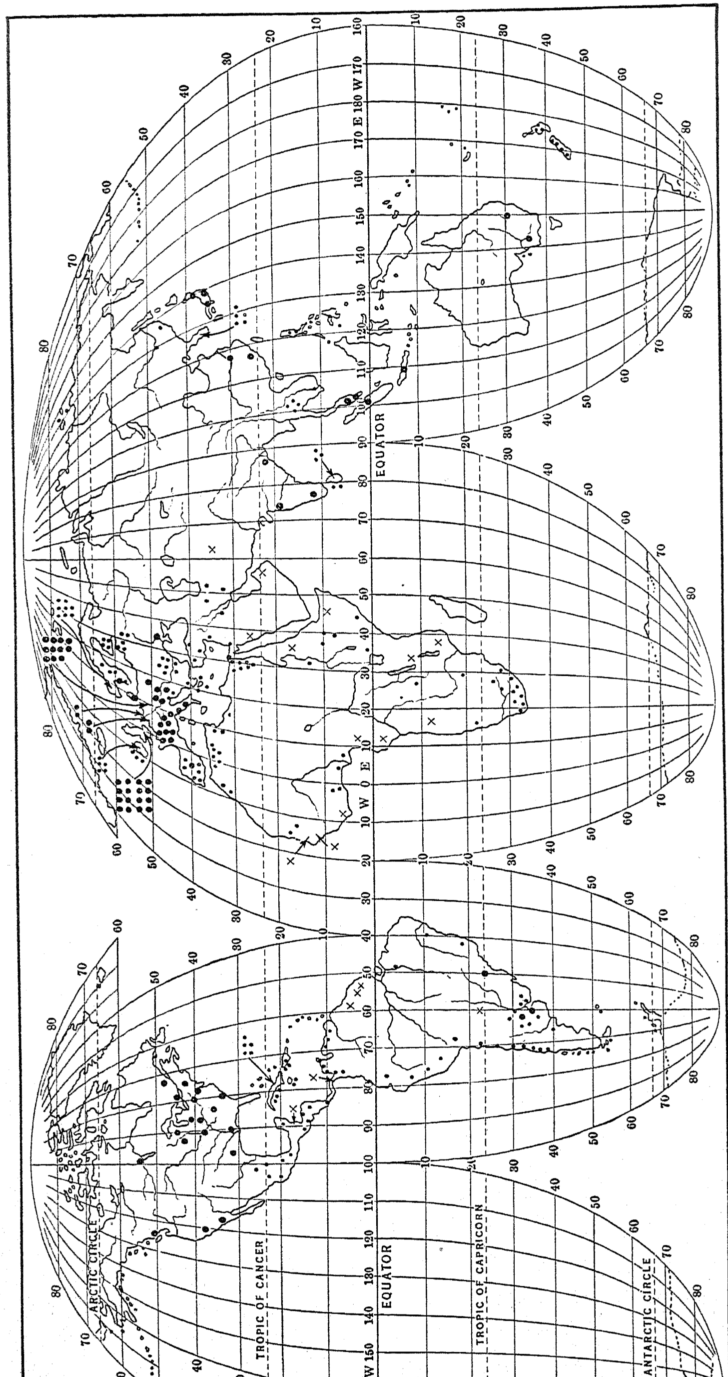


1. Stereographic. 2. Mercator. 3. Conical.

A—Types of Map Projections.

of the map, which is not true where the meridians or parallels are curved. Moreover, the parts of the map near the equator show the earth's features without distortion and with the correct relative areas. These advantages are offset by the fact that on a true Mercator projection the poles cannot possibly be represented, and high latitudes are so extremely exaggerated that they are usually omitted or arbitrarily reduced in size. Moreover, even in low latitudes the distances and areas begin to be exaggerated as soon as one moves away from the equator.

The conical projection (3 in A59) is made by placing a conical map sheet so that it touches the earth on the circle of latitude passing through the center of the map. Lines are drawn from the center of the earth to the cone. When the cone is opened the meridians are found to be straight lines and the parallels are curves. The parts of such a map near the



Goode's Equal-Area Homolosine Projection. *Courtesy of University of Chicago Press, Copyright*

A—The World's Total Trade Shown upon Goode's Interrupted Projection.

Large dots indicate 1 per cent of the world's total foreign trade; small dots, 0.1 per cent; crosses, minor amounts.

central parallel show no distortion or exaggeration. Maps of small areas are usually made on the conical projection, but for larger areas, such as countries or continents, it is common to employ a modified conical projection made by combining the conical projections for a series of parallels of latitude.

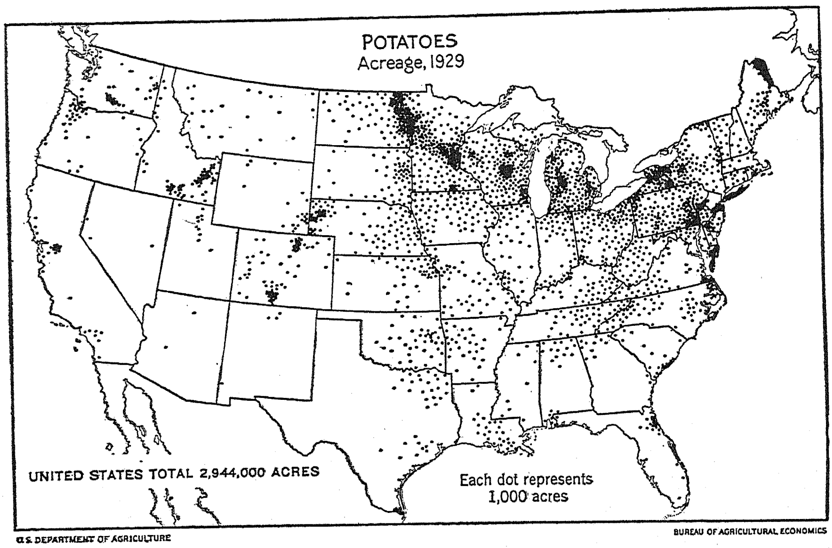
The Choice of Map Projections. In addition to the types of map projection illustrated in A59 there are hundreds of others. Some, showing the world in a single ellipse, appear in A101 and A116. Many maps are constructed on combinations of different kinds of projections, or on the same projection everywhere, but with the central meridian or central parallel different in different parts of the map. In recent years the world as a whole is often represented on split projections such as A60. The advantages of these are as follows: (1) the central meridian of each continent is a straight vertical line; (2) the parallels of latitude are at right angles to these lines; they are straight, and they are equally distant from one another at all points; (3) the areas are everywhere essentially correct, although as one goes away from the central meridian in each continent the shapes necessarily become more and more distorted. There are two main disadvantages: (1) the map is full of blank spaces so that oceanic distances cannot easily be estimated ; (2) the oceans and the blank spaces take so much space that even on a full-page map like A60 the continents are small. In this book another scheme is often used where world maps of the lands alone are needed. The oceanic areas are largely eliminated by shoving the Americas eastward and Australia and New Guinea westward. Thus, although A352 occupies only half a page, the continents are almost the same size as in A60 which occupies a whole page. It must always be remembered, however, that, inasmuch as the earth is a sphere, no flat map of a large area can possibly be correct in all parts. Toward the edges it is bound to depart from the exact facts in one or all of the main features which every map must show, namely, size, shape, and distance. In order to get correct ideas about all these features a good globe should be consulted frequently.

Maps as Geographic Tools

Among the many different kinds of maps used in this book to show the cultural features mentioned in the last two columns on page 4, two are so important that the method of making them will be described. One of these is illustrated by A62, which is a dot map showing the distribution of potato acreage in the United States. Each dot represents 1,000 acres, and is placed as nearly as possible in the center of the area where the potatoes are found. In some cases, such as New Mexico, so few potatoes are raised that those in thousands of square miles are repre-

sented by a single dot. In others, such as Long Island, parts of Minnesota, and Aroostook County in northern Maine, there are so many potatoes that the dots touch one another, giving a patch of solid black. Each dot in A62 is necessarily many times larger than it would be if it represented the area occupied by potatoes on a true scale. The general rule is to make the dots of such size that where they are thickest the map will be black. There are many modifications of dot maps. In A60, for example, the larger dots represent one per cent of the world's foreign trade, while the small dots represent one tenth of one per cent.

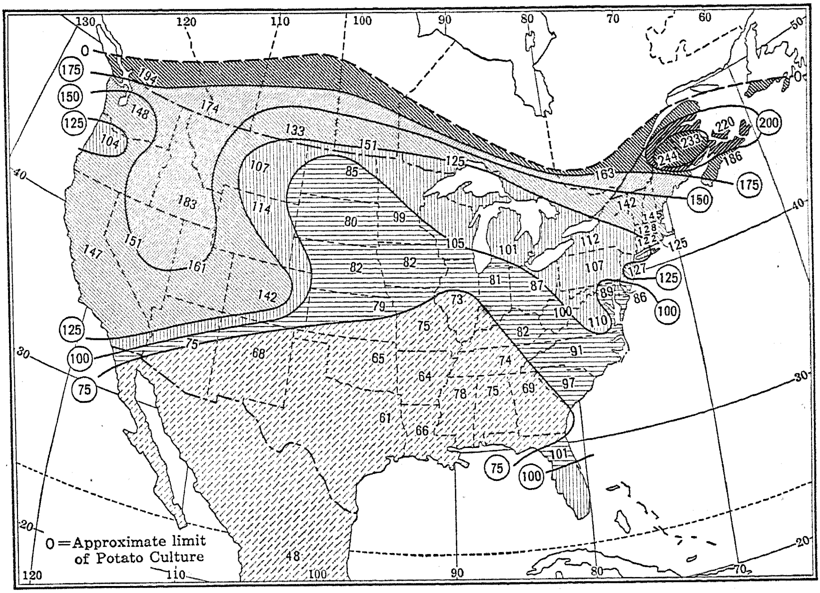
Isopleth maps are another useful kind. We may want to know what percentage of the cropland is devoted to potatoes, what price is paid per



A—Dot Map of Potatoes in the United States.

bushel, or how many bushels are raised per acre. *Ratios* such as these are well represented by lines called isopleths and by shading of different intensities. For example, A63 shows the number of bushels of potatoes raised on an average acre in each state, and in the provinces of Canada, during a 20-year period. The lines marked 75, 100, and so on, are called isopleths, or lines of equal weight. The line labeled 75, for example, means that south of it, until some other isopleth appears, the yield of potatoes averages less than 75 bushels per acre, while north of it the yield is more. Toward the north the yield increases more or less regularly, to a maximum of over 200 bushels per acre in Maine, New Brunswick, and Prince Edward Island. The isopleth map tells us various things which we could not possibly have guessed from the dot map, for example,

that the yield of potatoes per acre reaches its highest level close to the northern limit of that crop. The dot map, however, gives equally important information which we could never guess from the isopleth map, for example, that the potato acreage of the country is very irregularly distributed, being greatest in a band from the Middle Atlantic Coast to North Dakota, and having spots of strong concentration in the drier states farther west. Both dot maps and isopleth maps are so useful that every student of geography ought to get some practice in making them.



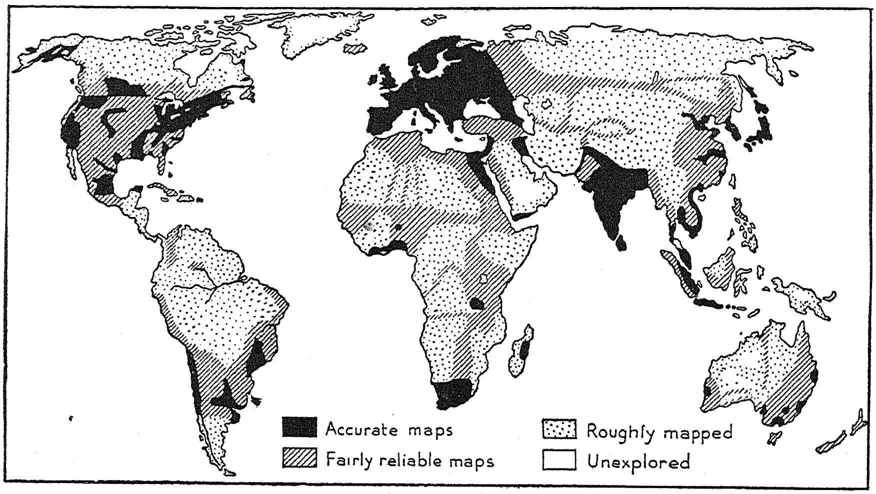
A—Average Yield per Acre of Potatoes, in Bushels, in the United States, 1910-1929.

Extent of World Mapping

In spite of their great usefulness accurate maps are available for only a small part of the world and for only a few of the human responses to the geographic environment. A64 shows that even in the United States less than half the country has been accurately mapped so that the relief as well as the location of rivers, cities, and so forth, is well shown. In every continent except Europe large areas are only roughly mapped. Even in Europe a considerable part of Russia has only moderately good maps, like those which are available for much of the interior of the United States. Every advanced country has at least one map-making agency, but maps are expensive and their construction is often put off in favor of such matters as support of the unemployed or preparations for war. In the

United States the Geological Survey makes topographic maps such as A56 and A58, while the Coast and Geodetic Survey makes maps of coastlines and harbors, designed for sailors. On this last kind of map hundreds of numbers indicate depths of water in fathoms.

During the present century many nations have been cooperating in making an "International Map of the World" on a scale of 1,000,000. In general each sheet of this map covers 4 degrees of latitude, but the width varies because of the decrease in the length of a degree of longitude as one goes away from the equator. All the maps are colored to represent altitude. Only about 300 of the proposed 1,500 sheets have yet been published. The American Geographical Society in New York has the



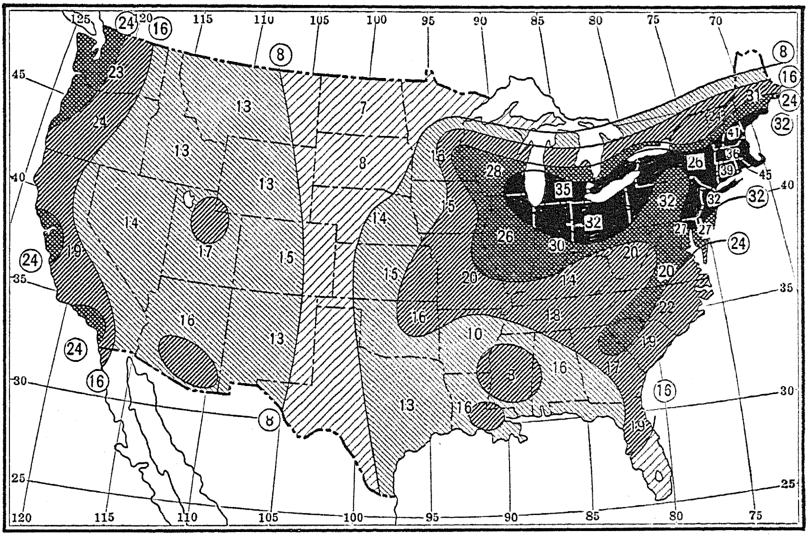
A—State of the Topographic Mapping of the World.

(Modified after Reeves.) From Raisz, *General Cartography*, McGraw-Hill Book Co., New York, 1939. Reprinted with permission.

distinction of having finished all the sheets of South America. Two of the great needs of geography are the completion of the primary mapping of the world, and the mapping of all sorts of resources and activities, a work which has barely begun.

Local Mapping. One of the most interesting parts of geography is the mapping of small areas. It is practical as well as interesting to make a map of an area no larger than a houselot. The features that can be shown include the location of shrubs, trees, flowerbeds, paths, and driveways, differences in the soil or slope, and uses such as clothes yard, dog kennel, or chicken house. Another kind of instructive local map is made by traveling along a road or street and noting in their proper places the type of occupance, that is, the uses to which the land is put. One map

might show vegetation, divided into grasslands, cropland, forest, and so forth, each kind being subdivided again into minor divisions according to crops, kinds of trees, etc. Another might show types of building, such as stores, factories, public buildings, apartment houses, and private houses of various sizes, or materials. Some of the Middle Western universities of the United States have done especially good work along this line.



A—Percentage of Gainfully Employed Persons Engaged in Manufacturing and Other Mechanical Industries Aside from the Building Industry, 1930.

QUESTIONS, EXERCISES, AND PROBLEMS

1. A. In this book or in an atlas, find maps on the following projections: (*a*) Mercator; (*b*) stereographic (or any projection showing two hemispheres separately); (*c*) homalographic (or any projection showing the whole world in a single ellipse); (*d*) conical (the type usually employed for maps of a continent or small area); (*e*) an interrupted projection.

B. Trace the form of each of the following regions according to each projection: (*a*) Greenland; (*b*) India; (*c*) Australia; (*d*) Alaska. In each case compare your tracings with a globe and determine which projection gives the truest idea of the real shape. Determine which projection causes the greatest departure from the truth in (*a*) area; (*b*) shape.

2. *Great Circle Sailing.* Steamships practically never follow lines of latitude or longitude. Moreover, they do not go in what seem to be the shortest courses on the map but follow "great circles," that is, circles whose centers coincide with the center of the earth. Find out why this is so by taking a globe and measuring with a string the shortest route from Seattle to Yokohama. Locate three intermediate

points on this route by latitude and longitude. Now locate these on an outline map of the world, and draw the route. Do the same for the following routes: (*a*) Santiago, Chile, to Auckland, New Zealand; (*b*) London to Panama; (*c*) Capetown to Boston. Write out your conclusions as to great circle sailing.

3. In A65 the figures in states show the percentage of the occupied persons engaged in manufacturing in each state in 1930. Lines have been drawn and appropriate shading has been added to distinguish the areas having the following percentages: (*a*) over 32, (*b*) 32 to 24, (*c*) 24 to 16, (*d*) 16 to 8, and (*e*) under 8.

A. From the *World Almanac* or some other source, procure similar figures showing the density of population per square mile, and insert them on two outline maps. On one map add shading like that of A65, but let state boundaries determine the limits of each type of shading. On the other, draw smooth lines, or "isopleths," like those of A65, and then shade.

B. Discuss the relative merits and defects of the two maps thus drawn. Which gives a truer idea and why?

C. Compare A65 with your own map, and state what connection you see between the two.

4. Try to make a map of a yard or other small area by triangulation, using a ruler instead of a telescope in order to get the direction from one point to another.

PART III

THE FUNDAMENTALS OF CLIMATE

CHAPTER V

CLIMATE AND THE CLIMATIC ZONES

A. Why Climate is Important

Climatic Barriers

Climate is the most important of geographic factors. In one sense of the word, climate is the average of the weather over a long period of years. In a broader sense, climate includes all the variations of the weather from day to day as well as from season to season. In this broad sense climate acts upon man in three chief ways: (1) It sets up barriers which limit his movements. (2) It is the main physical factor in controlling the nature and amount of most of the materials needed for food, clothing, and shelter. (3) It has a direct and important influence upon health and energy.

(1) *On the Ocean*. Climate, in the sense of weather, limits man's movements directly when a rainstorm keeps people in the house, for example, or a gale prevents ships from going to sea. Its chief effects, however, are indirect or in combination with other factors. For example, a large part of the difficulty in crossing oceans and mountains is climatic. America did not remain undiscovered so long merely because of the broad ocean, but because people feared that climatic conditions in the form of storms and winds would wreck them, or prevent them from coming home again. Today travelers do not fear the ocean when it is calm, but only when it is disturbed by climatic influences such as winds, waves, fogs, and icebergs like that against which the *Titanic* struck with 1,500 people on board. The effectiveness of the ocean as a barrier would be greatly reduced if the climatic dangers could be eliminated.

(2) *Among Mountains*. In the same way the barrier of the mountains is largely climatic. In crossing the Himalayas from India to western China the steep slopes and thin air are indeed a great hindrance. Yet these direct effects of relief are far less dreaded than fierce snowstorms,

followed by the blinding glare of the sun. Worse still are the climatic conditions that cause avalanches which sometimes bury whole caravans, and glaciers where man and beast sometimes plunge to their death in deep crevasses. Worst of all is the scarcity or absence of vegetation which leads to a corresponding scarcity or absence of people. The weather is so cold that on vast stretches of high barren plateau no one can dwell and not even grass can grow. It is so difficult to bring food there that among the caravans on the way from India to western China hundreds of animals, weakened by exposure and scarcity of food, die each year. In a single day's short journey the author of this book counted 32 dead horses that had recently fallen by the trail; the next day he counted 220; and the third day 474, in addition to one human corpse. All this was due to the cold climate acting either directly through storm and wind, or indirectly through the absence of vegetation.

(3) *Within the Frigid Zone.* The climate of cold regions erects barriers even more impassable than those of mountains and oceans. The world's largest unexplored areas are the snowy plateaus of Antarctica and Greenland and the coldest regions of northern America and Asia. So impassable are the great fields of snow and ice that the poles were not reached until the present century in spite of attempt after attempt. Peary reached the North Pole and Amundsen the South only after long experience had taught explorers how best to use dogs and other means of transportation, how to carry and store great supplies of food and fuel, and how to provide the warmest clothing and shelter. Commercial use of the oceanic route north of Siberia became possible only in the 1930's when a relatively high average temperature for several years had reduced the amount of ice.

(4) *Deserts.* Next in difficulty to the climatic barrier of cold regions come hot, dry deserts. In southern Arabia the desert climate makes such a barrier that not until 1932 did any explorer ever penetrate a region hundreds of thousands of square miles in extent. The natives fear this region, partly because there is no water, and partly because of the extreme difficulty of climbing the lofty dunes of dry, sliding sand piled up hundreds of feet by violent winds. When the wind dies down the dust settles in the low, flat areas between the dunes. As no rain falls for years the dust becomes so deep that one sinks in it above the ankles, even on the edges, and every movement raises it in stifling, choking clouds. No one dares go farther for fear of sinking deeper and then falling and being smothered. In many ways, however, the worst places of all are vast smooth expanses of monotonous gravel, 150 miles wide in some places, and everywhere devoid of both water and vegetation.

(5) *In Tropical Forests.* The damp heat of tropical forests creates

a barrier to human movement almost as serious as that of deserts. Not only does such heat assist the growth of dense forests through which travel is almost impossible, but in addition it is most exhausting to human energy, and fosters some of the world's most deadly fevers. Even so wise and vigorous an explorer as Theodore Roosevelt was baffled by the barrier of the South American forests and could not escape the ravages of tropical fever. Thus on oceans, among mountains, in deserts, and in both high and low latitudes such climatic conditions as high winds, intense cold, extreme aridity, and damp tropical heat are among the circumstances most unfavorable to man's movement from place to place.

Climate and the Food Supply

The effect of climate and weather on man's material needs can best be illustrated by considering the food supply. Materials for clothing and shelter vary from place to place in the same way as food. The weather, more than anything else, determines the nature and abundance of vegetation and hence of food. People who have spent their lives among the forests and meadows of a moist temperate climate such as prevails in the northern and eastern United States often feel as if such vegetation prevailed everywhere. Similarly a person who has always lived in a dry climate is likely to feel as if all parts of the world ought to consist of thriving irrigated orchards and fields surrounded by barren land with only a few scraggly bushes and tufts of dry grass. The man who lives among the cool forests and meadows of New Brunswick is almost certain to raise such crops as cattle, oats, turnips, and potatoes. Unless he builds expensive greenhouses, he cannot raise grapes, olives, and oranges, such as are the mainstay of a peasant in warm, dry, southern Greece, or even corn, such as is raised by his fellow Canadians near Toronto. These examples illustrate how greatly food may vary in response to climate.

Variations in the food supply in their turn have much to do with people's habits. Since the Eskimo, for instance, lives in a climate which almost forbids the growth of vegetation upon the land, but not in the sea, he must catch sea animals for food. Therefore he is a good hunter and bold fisherman, and wanders far and wide upon the water. He is as much at home in his *kayak* as upon the land. The Fiji Islander, on the other hand, lives in a climate where a few breadfruit trees, coconut palms, and the lilylike taro bulb furnish food for himself and his family with little work. That is one reason why he spends much of his time sitting idly at home, and is what we call lazy, although he works hard enough when he goes fishing, for example.

Climate in Relation to Health and Energy

Man's health and energy are influenced by climate both directly and indirectly. In the temperate zone everyone knows that on some days the air is invigorating and on others depressing. Most people work slowly on hot, muggy days; if they work fast, the result is unusual weariness. On a clear bracing day in the autumn, on the contrary, we often feel as if we could do anything no matter how hard. Still later, on a cold winter day, we sometimes run to keep warm, but in the house we feel a little dull and stupid. Thus in many ways our activity of mind and body is influenced directly by the weather. This is one chief reason why tropical races have never made much progress. Their climate is too warm. On the other hand, such people as the Chukjees of northern Asia are made stupid and their progress is retarded because their climate is too cold.

Climate also influences the body indirectly, especially through diseases. When Negroes or other tropical races change their climate by coming to the North they are likely to suffer from tuberculosis, pneumonia, and similar diseases of the lungs. In tropical countries the diseases encouraged by the climate are far worse. There the climatic conditions favor many disease-bearing insects such as the *Anopheles* mosquito, which carries malaria, and the *Aedes* mosquito, which carries yellow fever. How bad the tropical diseases are may be judged from the account of a recent traveler in the Amazon Basin. He speaks of the change in some of his comrades after only two weeks in the steaming, insect-infested forest. "Several of them were already suffering from violent attacks of malaria, and their faces were colorless and sallow; others who had been in the region longer stared at our boat with sunken, lusterless eyes in which not even a vestige of interest in our visit or of hope was evident; a few had apparently reached the stage where the sight of the twelve newly made graves on the hill-top no longer aroused feelings of dread or apprehension, but rather of indifference tempered with longing for a welcome release."

The Great Variability of Climate

Among the five great elements of physical environment, climate is by far the most variable. The location of a place in respect to the earth as a globe does not change for millions of years; the land forms and water bodies do not change preceptibly during many generations; and neither the soil nor minerals change appreciably except where man intervenes. Climatic conditions, on the contrary, are constantly changing. In the temperate zone the weather is rarely the same two days in succession. A downpour of rain today is followed by cloudless skies tomorrow; a warm, muggy day by one that is crisp and bracing. Some winters are long and so cold

that much snow accumulates; others are short and open. One year may be warm and wet, and the crops abundant; but the next year may be so dry that the farmers can scarcely raise enough to make a living. In tropical and polar regions there are marked differences between different years, although the variability is not so great as in the dry continental interiors.

Climatic variations last through long periods as well as short. About twenty-five or thirty thousand years ago occurred the last climax of what is known as the glacial period. Ice many hundred feet thick covered northwestern Europe and most of North America north of the Missouri and Ohio rivers. Since that time the climate has changed so that most of the ice has melted and some of the places which it covered have become the most progressive parts of the world.

B. A Simplified Rotating Globe

Rotation as a Controlling Climatic Factor

The first step in understanding climate is to know why it differs from place to place. These differences depend on four factors: (1) the earth's rotation, (2) the revolution of the earth and the inclination of its axis, (3) the distribution of land and water, and (4) the relief of the lands. In this chapter and the next we shall study each of these four factors separately and consider its effect upon temperature, pressure, winds, and rainfall.

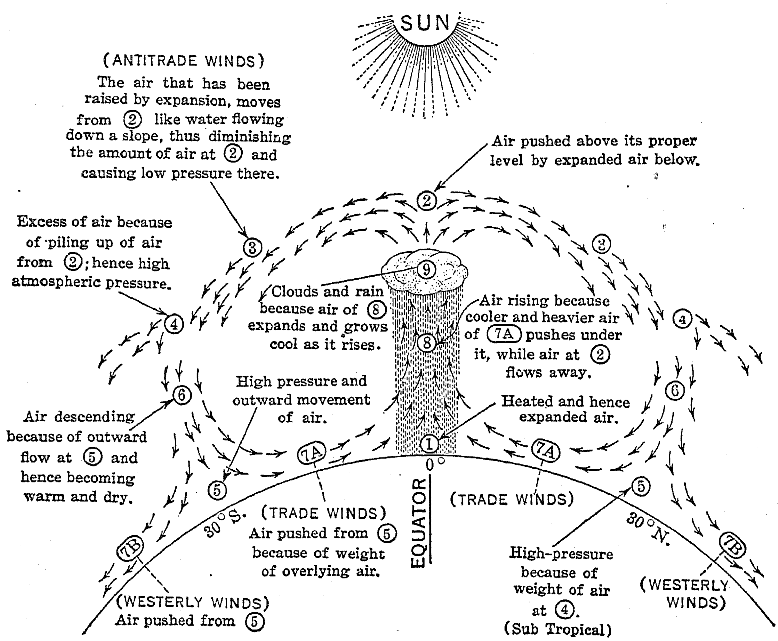
Terrestrial Distribution of Temperature

The fact that the sun shines on a globe which rotates on an axis causes the area where the temperature is high to form a *belt* surrounding the earth completely where the sun's rays strike vertically. It also causes belts of lower temperature to encircle the earth at higher latitudes. This seems to be such a matter of course that we forget that it is possible only on a *rotating* globe. The rapidity of the rotation, once in twenty-four hours, prevents the temperature, winds, and rainfall from becoming so extreme that life is impossible. If the earth did not rotate, a single day and night would last a year. At any given place the movement of the earth in its annual orbit would at some time during the year bring the sun above the horizon. Then for three months, as the sun slowly climbed higher, the air would grow warmer and then hotter, until the temperature became unendurable. Three months later, the sun would set. Then would come a night of six months as cold and benumbing as the day had been scorching and enervating. At all times there would

be a tremendous contrast between the hot and cold sides of the earth. This would cause winds and storms of a violence wholly unknown at present. Some such condition is supposed to prevail on Venus. That planet appears to rotate very slowly, always keeping the same face toward the sun. Hence, instead of zones of climate parallel to the equator, it presumably has a hot side and a cold side; and tremendous winds must prevail at all times. The earth, with its rapid rotation and relatively small variations of temperature within any one belt—except in continental interiors in fairly high latitudes—is very fortunate.

Rotation and Atmospheric Pressure

Another effect of the earth's rotation is a series of *belts* of atmospheric pressure. For the sake of simplicity let us suppose that the earth's axis is vertical to the plane in which the earth revolves around the sun.

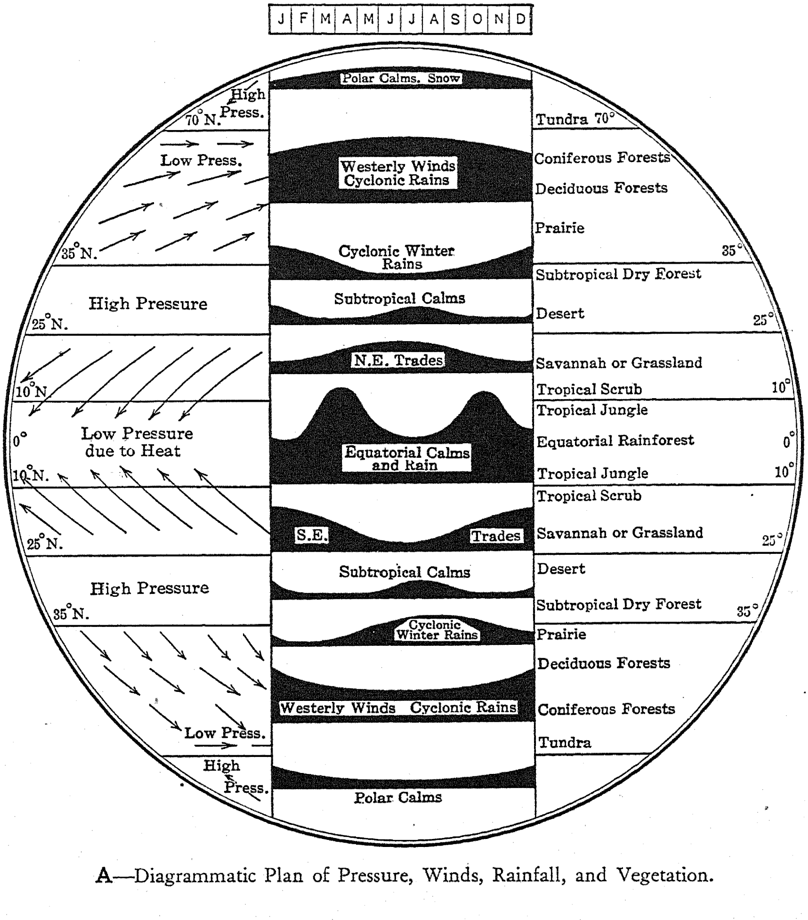


A—Ideal Diagram Illustrating Atmospheric Circulation and the Origin of Climatic Zones.

Then there would be no seasons. Let us also suppose that the earth's surface is everywhere uniform without continents or oceans. Thus there would be no contrasts between places in the same latitude, some having mild oceanic climates like that of Ireland, and others, extreme continental climates like that of Lake Baikal. If the sun should be blotted

out long enough, such a globe would have essentially the same temperature everywhere. The atmospheric pressure, however, would decline steadily from the equator to the poles. The reason for this is that the earth's rotation makes the air bulge at the equator in the same way that the solid earth bulges. Let us disregard this for the present.

Now let the sun begin to shine in normal fashion. Belts of temperature and atmospheric pressure will soon come into being. Since our supposed globe stands with its axis vertical to the sun's rays at all times, the equator will always be the warmest place, and the temperature will gradually decline towards the poles. A72 illustrates how the zones, or belts of atmospheric pressure, will arise. Follow the numbers there and see what happens. The hottest belt around the earth is at 1.



A—Diagrammatic Plan of Pressure, Winds, Rainfall, and Vegetation.

Accordingly there the air expands more than anywhere else. This expansion pushes up all the overlying air, so that at 2 the air is raised above its former level more than anywhere else. Imagine now that the air has an upper surface, and bear in mind that air flows downhill like water. Under such circumstances the air at 2 will begin to flow poleward on both sides as shown at 3. This means, of course, that air is removed from 2 and added to other places such as 4. Hence the amount of air at 2 will be less than anywhere else, while at some place like 4 the addition of air from 2 will be greatest. Hence at 2 the air over any given area of the earth's surface will weigh less than elsewhere, and we shall have a zone of low atmospheric pressure extending completely around the earth. At 4, on the contrary, the air will weigh more than elsewhere, and we shall have a belt of high pressure (5 in A72). On an average the center of this subtropical high-pressure belt is about 30° from the equator.

Farther toward the poles the atmospheric pressure decreases because the westerly winds and cyclonic storms to be described later make a sort of whirlpool. Around the poles, however, the low temperature causes so much contraction of the air that other air flows in on top, and we have a cap of high pressure over each pole. Thus from the equator to either pole there are four belts of atmospheric pressure as shown on the left side of A73: first, equatorial low pressure due to heat; second, subtropical high pressure due to piling up of air from equatorial regions; third, mid-latitude low pressure due to the movement of the air in the great whirl of the westerly winds; and fourth, polar high pressure due to low temperature.

Winds on a Simplified Globe

Let us now see how the pressure belts would influence the winds on our simplified globe. We will begin with the subtropical belts of high pressure, the starting point of two of the earth's chief types of surface winds. The weight of the upper air in the regions of high pressure (4 in A72) causes the air to settle slowly downward, (6), but the movement is so gentle that it cannot be felt. Hence the high-pressure belts form regions of *subtropical calms*, the "horse latitudes," as they are called.

On the borders of the subtropical belt of high pressure this downward movement in the central region forces the air outward and forms regular winds on the earth's surface (7A and 7B). These blow toward the equatorial belt of low pressure on one side (7A), and toward the subpolar low-pressure area on the other (7B). In the warm equatorial belt of low pressure, as we have seen, the air is heated and expands so that part flows away at the top. This reduces the mass of the air so much that the cooler, heavier air from the neighboring high-pressure

areas is able to push in below and lift the warm, light air (8). This cooler air is in turn warmed and pushed up. Thus an ascending current of air is formed in the equatorial belt and there are no steady winds. In other words the ascending current is accompanied by *equatorial calms* just as the descending current is accompanied by subtropical calms.

How Rotation Influences the Direction of the Winds. Although the winds that blow out from the subtropical high-pressure area start toward the equator and the poles, the rotation of the earth gradually deflects them. In the northern hemisphere the deflection is toward the right and in the southern toward the left. Thus in the northern hemisphere a wind that starts toward the pole from the northern side of the subtropical belt is gradually deflected to the right until it becomes a southwesterly wind, that is, it blows from the southwest, for winds are always named from the direction whence they come. Further deflection causes such a wind to become westerly, as is shown by the arrows on the left of A73, and even northwesterly. Thus on the northern side of the northern subtropical belt of high pressure there is a belt of prevailing "westerlies." Similarly the air pressed out from the southern subtropical belt toward the south pole starts as a north wind, but by deflection to its left becomes a northwest and finally a west wind. This gives rise to a belt of "westerlies" in the southern hemisphere as well as in the northern.

Let us go back now to the northern hemisphere. On the southern side of the northern subtropical belt the air starts equatorward as a northerly wind. It is deflected to its right just as in the westerlies. Hence it blows as a northeast wind. The direction and steadiness of such winds have caused them to be called the "Northeast Trades." In the southern hemisphere similar winds start equatorward as southerly winds from the subtropical belt, but because of a left-handed deflection become southeast winds. This, with their steadiness, gives them the name of "Southeast Trades." *

The regularity and strength of the trades are so great that for centuries sailing ships from England and France have found it to their advantage to go south to the tradewind zone in order to be blown westward to America. On the return voyage, on the other hand, if a ship started from Florida, for instance, it went north at first in order to get out of the tradewinds into the westerlies which would blow it back to Europe. With the increasing use of airships the direction of the wind

* To understand the deflection of the winds by the earth's rotation, suppose yourself to be in the northern subtropical belt of high pressure. Face the equator and begin to walk southward, but as you proceed, turn more and more to your right. Your course will correspond to that of the northeast trades. Repeat the experiment to represent the southeast trades, and the westerlies of each hemisphere, remembering that the earth's rotation causes deflection to the right in the northern hemisphere and to the left in the southern.

is becoming of still greater importance. It is worth while for an airship to go hundreds of miles out of its direct course in order to find favorable winds.

The discovery of America was made easier because Columbus happened to get into the tradewinds which blew him across the ocean. The first aircraft to cross the ocean, on the contrary, used the westerlies instead of the trades because they wanted to cross where the ocean was narrow. Hence in 1919, when Englishmen were trying to forestall Americans in being the first to make a transatlantic flight, they brought their airplane by steamer to Newfoundland in order to fly with the prevailing winds.

The westerlies and the trades together with the regions of calms give rise to nine wind belts. These may be seen in the center of A73, but note that in both the hemispheres some names are pushed off their proper positions by the shaded areas representing rain. In the center lies the equatorial belt of low pressure, rising air, and calms. On the north side of this belt lie the northeast trades and on the south the southeast trades. Next to them come the two subtropical belts of high pressure, descending air, and calms. Still farther toward the poles come the westerlies blowing generally from the southwest in the northern hemisphere and from the northwest in the southern. Finally around the poles we have two areas of irregular winds and calms.

Zones of Rainfall on a Rotating Globe

On a simplified rotating globe, such as we are here dealing with, the zones of rainfall would correspond to the belts of temperature, pressure, and winds that have just been described. Rain occurs because air is cooled (9 in A72). Everyone knows that warm air can hold more moisture than cold.* That is why wet shoes dry so much better beside the radiator than in the vestibule or outside the front door. When air rises, the pressure upon it decreases because there is less air above it. Therefore it expands, and in so doing grows cool. When we fill a tire with a handpump we notice that the pump cylinder gets hot, for the compression of air develops heat. Conversely when air expands it loses heat and grows cool. Thus rising air becomes cool. It gives up moisture in the form of clouds, much as warm, moist air gives up dew when it touches a pitcher of ice water and thus causes the pitcher to "sweat." Hence clouds

* In reality the air does not hold the moisture, for the molecules of both water vapor and air are so small and far apart that they fly about in the same general area and interfere with one another very little. It is *space*, not air, that holds water vapor, but the expression used in the text is so common that it is employed here and elsewhere.

are formed and rain falls upon any part of the earth where the air rises sufficiently.

Rainfall of the Equatorial Belt of Low Pressure. In no other part of the world does air rise so steadily and so abundantly as in the equatorial belt of low pressure. Therefore this is the region of greatest rainfall. A73 shows what happens here. During the rainy season of the equatorial belt, the mornings are usually sunny; clouds gather toward noon, showers fall in the early afternoon, and then the air clears. So regularly does this happen that people count on it, and plan accordingly. "Let's play tennis an hour after the shower," one man may say to another.

Rainfall of the Tradewind Belts. Since the air in the tradewind belts moves horizontally its temperature and hence its capacity to hold moisture suffer practically no change because of increase or decrease of pressure. Some change, however, arises from the fact that on its way toward the equator the air moves from cooler to warmer parts of the earth's surface. Therefore the air gradually grows warm and the capacity of space to hold moisture is increased. Hence the probability of rain grows less and less. That is one reason why the Sahara is so arid.

Deserts of the Subtropical Belts of High Pressure. Poleward from the drying tradewinds the air descends in the subtropical belts of high pressure and calms. Therefore, like the compressed air in an automobile pump this air grows warmer. Hence the amount of water vapor that can be mingled with it constantly increases, and when the dry air reaches the earth's surface what moisture it finds on the ground is eagerly evaporated. Thus a dry belt is produced and the subtropical regions are among the driest parts of the world.

Rainfall of the Belt of Westerly Winds: Cyclonic Storms. In the belts of westerly winds the air moves horizontally part of the time. This movement may cause a little rain because the air is moving from lower to higher latitudes and hence is growing cool. The chief reason for the abundant and regular rainfall of the belts of westerly winds, however, is that they are regions of cyclonic storms. Such storms are areas of low pressure, 500 to 1,000 miles or more in width. The winds blow toward the centers of such areas, but not directly, for they are deflected to the right in the northern hemisphere and to the left in the southern. This causes the air in such areas to move spirally in great whirls, and hence gives rise to the term *cyclonic,* which means wheel-like. Sometimes cyclonic storms of small area and great severity occur in the tradewind belt. These tropical cyclones are called hurricanes. Tornadoes also, which are often wrongly called cyclones, are cyclonic in character, but cover only a small area and are very severe. Some thunderstorms are of the same kind, but less severe. By far the most important cyclonic storms,

however, are those which cause the ordinary changes of weather in the United States, Europe, Japan, Argentina, New Zealand, and other parts of the belts of prevailing westerlies.

Ordinary cyclonic storms, or cyclones, as they may properly be called, are always associated with anticyclonic areas or anticyclones. These are areas of high pressure which may be 500 to 1,000 miles in diameter or may sometimes cover a continent. The high pressure of anticyclonic areas causes the winds to blow outward in all directions. These outblowing winds naturally move toward the low-pressure areas of the cyclones. Both anticyclones and especially cyclones are carried forward in the general drift of the westerly winds. Sometimes the center of a cyclonic storm moves 1,000 miles in a day whereas at other times it moves only a few miles.

Tropical and Polar Air Masses

During the last few decades measurements of temperature, winds, and pressure in the upper air by means of kites and balloons have shown that cyclonic storms are the result of the coming together of two distinct types of air masses. One type is tropical. It comes from oceanic regions in low latitudes, and moves toward higher latitudes. Tropical air masses of this kind are warm and moist. They consist of the kind of air that people in the United States are familiar with when south or southeast winds blow before a storm. When such air is cooled by rising, by reaching higher latitudes, or by coming in contact with cold land, its moisture condenses into fog or cloud, and rain usually falls. The other type of air mass consists of air that has become cool and dry at a high elevation over continents and in high latitudes. Such polar air masses generally move toward the equator and often have also an easterly motion. The cool air that comes with a west wind after a storm is of this sort.

A cyclonic storm is formed when a polar air mass meets a tropical air mass. Of course they do not meet along a sharp line, for one type of air mixes with another even more easily than warm water mixes with cool. Nevertheless, we know very well that before a storm we often notice that warm, moist air comes in from the south. A warm, tropical front, as it is called, has swept in from the ocean far to the southeast, south, or southwest, as the case may be, depending on where we live. If a polar air mass is not too far away, the lower part of the tropical air mass is checked, thus causing the tropical air farther back to pile up and overrun the front part of the tropical mass. This cools the part of the tropical air that has to rise, thus leading to clouds and rain. After a few hours, or sometimes after a rainy spell of several days, the polar air, being heavier than the other, pushes its way under the tropical air, and

a cold front arrives. When this happens the wind changes to a westerly direction and the temperature falls. Rain may continue for some hours because masses of moist tropical air are still being lifted up by the polar air. In winter it is not uncommon for rain to change to snow at this time. This series of changes, beginning with the arrival of the warm tropical air and ending with a cold wave, constitutes a cyclone or cyclonic storm.

At the end of such a cyclone the tropical air disappears and polar air gives us the clear bracing weather that commonly comes after a storm. This phase of the weather is the part called an anticyclone. It usually lasts longer than a cyclone, usually several days in the United States, and sometimes a week or more. While it lasts, the weather remains fair and tends to grow warmer in summer because the sun shines more than half of the time. In winter, on the contrary, especially when snow reflects the sunlight away from the land, the long nights allow the earth to cool off faster than the short days can warm it.

Cyclones and anticyclones—tropical air masses, polar air masses, and their meeting and mixing—are of the utmost importance to man. The cyclonic storms trouble the farmer in summer because they bring rain when he wants, perhaps, to get in his hay. They trouble the railroads in winter by piling up deep drifts of snow. They bring heavy rains which make floods like those which at various times have almost annihilated such towns as Johnstown, Pennsylvania, and Dayton, Ohio. Yet in spite of these disadvantages, cyclonic storms are one of the best things that a country can have, for they bring rain at all seasons. In the same way anticyclones are both a trouble and a blessing. They trouble the peach grower in New Jersey, for example, by bringing frosts when the trees are in blossom. They do great good, however, because in combination with cyclones they cause constant changes of weather, and these are one of the best aids to health and a great stimulus to work.

Rainfall of Polar Regions

High latitudes might be expected to have much precipitation in the form of either rain or snow, because the pressure is low. As a matter of fact, however, they have little because the air is so constantly cold that it can absorb little moisture. Hence when the air rises in storms it yields only slight precipitation. In the very highest latitudes, where the pressure rises somewhat, there is still less snow because cyclonic storms do not penetrate so far. What little snow does fall, however, lasts indefinitely and may accumulate in icesheets such as those of Greenland and Antarctica. The low temperature and consequent high pressure over such icesheets cause terrific winds to blow out from them. Such winds are

one of the worst things that Arctic explorers have to face on the borders of Antarctica and Greenland.

C. A Revolving Globe with an Inclined Axis

How the Earth's Revolution and the Inclination of Its Axis Affect the Climatic Belts

If the earth's axis were not inclined to the plane of the orbit in which the earth moves around the sun, the climatic belts would always remain in the location shown in A73. Hence there would be no seasons. Since the axis is inclined, however, and the vertical rays of the sun migrate back and forth from latitude 23½° S to 23½° N, the heat equator, and with it all the climatic belts, migrate similarly and cause seasons. These, as we have seen, produce a profound effect upon man's life. If the sun stood always at its most southerly position the climate of the northern United States would permanently become almost like that of the poles, and only people with habits much like those of the Eskimos would be likely to live there. If the sun stood always at its most northerly position, conditions would not be quite so bad, but the heat of July would prevail all the year, and people would become as inactive as those of the tropics.

The effect of the migration of the climatic belts upon rainfall is especially interesting. It causes the rainy season to come in summer in some places and in winter elsewhere (A73), while still other regions have rain at all seasons. Thus it does much to determine which regions are the best for farming. Suppose you had a choice between a farm in northern Texas and one in northern California, each farm being in the center of a plain where the soil is excellent, but where irrigation is expensive. Suppose also that you knew that both places had the same rainfall, an average of 20 to 25 inches a year, and the same temperature, an average of about 60° F. for the year as a whole. In Texas and California there are places of just this kind. What kind of farming would you plan in each case and how would you expect to live? If you were wise you would ask the Weather Bureau at Washington for monthly rainfall records of each section. You would find that Texas lies far enough south to receive abundant summer rains while this part of California is in the subtropical belt of winter rains. Hence during the six months of the growing period from April to September the Texas farm would get 16 inches of rain and the California farm only 4. Unless you could spend a large sum to bring water for irrigation this particular California farm would be of value chiefly as a cattle range, while on the Texas farm you could raise corn and other crops. If irrigation were pos-

sible, however, you could raise better vegetables and especially fruits than on the other farm.

Why Equatorial Regions Have Two Wet and Two Dry Seasons. The central section of A73 illustrates the effect of the seasonal migration of the earth's climatic belts upon rainfall. The shaded areas indicate the rainfall month by month throughout the year in various latitudes. To begin with the equatorial belt in the center, notice that in January there is less rain than usual. The sun is then so far south that the equator is under the influence of the northeast trades with their drying effect. As the sun moves northward the abundant equatorial rains come with it. Hence the rainfall increases. It reaches a maximum in April or May, a month or more after the sun has passed the equinox, for the seasons usually lag a little behind the sun. Then as the sun goes northward to the Tropic of Cancer, the rainfall once more diminishes. The belt of southeast trades swings over the equator and in July there is again less rain.

As the sun and the accompanying rain belt move southward once more, the rainfall at the equator increases until after the September equinox, only to diminish as the equatorial belt passes southward and the northeast trades again prevail at the end of the year. Thus at the equator, although there is no summer or winter, there are four seasons: (1) a relatively drier, but not dry, season when the sun is in the south; (2) a wet season when the sun crosses the equator northward; (3) another relatively dry season when the sun is in the north; and (4) a wet season after the sun crosses the equator on its way south. This type of rainfall with two wet and two drier seasons prevails with more or less modification in the equatorial regions of South America, Africa, and the East Indies. In spite of the two drier seasons, such a climate has rain at all seasons.

Why Subequatorial Regions Have One Wet and One Dry Season. In the two parts of A73 illustrating the conditions of rainfall in the trade-wind latitudes 10° to 20° from the equator, quite a different seasonal distribution is seen. These low latitudes are near the margin of the equatorial belt, and hence are called subequatorial. When the sun is far south in January it carries the equatorial rain belt with it, so that the southern subequatorial regions receive a heavy rainfall as appears in A73. On the other side of the equator, however, the southward migration of the climatic belts causes the drying trades to blow over the subequatorial regions and gives them a dry season in January, as is shown in the figure. Six months later the conditions are reversed.

In actual practice the dry season often has no rain at all for a month or more near the equator and for longer periods up to six or eight months

farther away. The subequatorial belts lie in such low latitudes that they have no cool season that can be called winter, and hence no spring or fall. They really have two seasons, wet and dry, and are well called the Wet and Dry Low Latitudes. Southern Mexico, northern Australia, and a strip of northern Africa south of the Sahara have this type of rainfall.

The Seasons of the Desert Belt. The third type of rainfall, tropical calms in our diagram, is that of the desert belts 25° to 30° from the equator. When the sun's rays are vertical near the equator these latitudes in both hemispheres lie in the belt of subtropical high pressure or else on the borders of the tradewinds. Hence they receive no rain. They are warm, or more often hot, at these times, because the sun's rays are only slightly oblique, and the sky is unclouded. In January the climatic belts swing so far south that the northern desert belt may be touched by the edge of the westerlies, and hence occasionally receives a little rain. At the same time the southern desert belt is touched by the edges of the equatorial rain belt. Six months later the more equatorial parts of the desert belt may get a little rain from the northward shifting of the equatorial rain belt. Thus while some dry regions have winter rain and others summer rain, a few have two brief periods of slight rain. This gives four seasons: (1) a slightly rainy winter with pleasant temperatures, (2) a hot, dry spring or "fore-summer," (3) a hot summer with a little rain, and (4) a dry, hot autumn, or "after-summer." Southern Arizona and central Arabia are examples of this type.

Why Subtropical Regions Have One Wet and One Dry Season. In the next diagrams we come to the subtropical regions. Here in latitudes 30° to 40° the belt of high pressure and aridity rules during the summer of each hemisphere, while in winter the belt of westerlies swings equatorward and gives rain from frequent cyclonic storms. Notice how the shaded areas of A73, representing rainfall, are really the same for the two hemispheres in this and all other belts except that the seasons differ by six months in their time of arrival. Thus the subtropical rains of the northern winter in January correspond to the rains of the southern winter in July. California and such Mediterranean countries as southern Italy, Greece, and Palestine, are good examples of the subtropical type in the northern hemisphere, as are Cape Colony and central Chile in the southern hemisphere.

The Seasons of Temperate Regions. The next diagrams represent the fortunate temperate regions where westerly winds and cyclonic storms prevail, and there is plenty of precipitation, that is, either rain or snow, at all seasons. There the seasons depend mainly upon changes of temperature rather than rainfall. The northern and eastern United States and Western Europe, together with Japan and New Zealand, are the

chief examples of this type. The people who live there are always talking about the weather because it keeps changing. This is quite unlike the dry belts, where little is said about the weather, because it is almost always clear. There the water supply is one of the chief subjects of conversation. The abundance of water at all seasons in regions of cyclonic storms makes it possible for farmers to live everywhere. People do not have to be crowded into compact villages near a central water supply as they do in dry countries. In countries such as France, Germany, and Poland, to be sure, most of the people live in villages, even though they are farmers and have to walk a long way to their fields. In the United States, Canada, and Scandinavia, however, they live on their farms, even though they are miles from neighbors. This has helped to make the people of such regions more resourceful and better able to take care of themselves than those of other parts of the world.

Even Distribution of Polar Precipitation. Finally, well toward the poles we find some precipitation throughout the year, but chiefly in summer, the winter being too cold. The amount is small because cold air cannot hold much moisture.

With certain modifications due to the continents and their relief the rainfall of any part of the world belongs to one of the types shown in A73. When these types are understood one can easily judge of the probable nature of the seasons in any part of the world. Thus one can appreciate the effect which the seasons are likely to have upon farming and other industries about which he reads, and also upon his own comfort and pleasure if he travels in distant regions.

Our Own Seasons and Weather

The climate in which any one of us lives belongs more or less closely to one of the types described on previous pages. It will pay to make a diagram of your local rainfall and temperature according to monthly averages, and find out how closely it resembles any of those in A73. Another interesting thing is to take the daily weather record and plot the maximum and minimum temperatures day after day for one or two winter months and for a similar period in summer. The amount of variability from day to day is normally greater in winter than in summer. Such a diagram will also show how much the weather varies from day to night and from one day to the next in cloudy weather compared with clear weather. The greatest changes usually come at the end of storms. Another interesting feature is the size of the changes of temperature from day to night and from one day to the next in summer compared with winter.

Examine also the precipitation record. How much of the precipitation comes in the form of rain and how much is snow? How much of the

time do clouds cover the sky? How frequent are fog, hale, thunder-storms, and ordinary rains? Is there much difference in the amount of precipitation in summer and winter? What is the largest amount that ever falls in one day? Since records began to be kept in your vicinity, what years, months, and days have been the hottest, coldest, driest, most rainy, or most extreme in other ways? What is the greatest change that ever occurs from night to day or from one day to the next? How long a period of almost uniform weather does your home ever have?

All these questions can be answered if a long weather record is available. Many of them can be answered, in part at least, if each class in human geography keeps its own weather record, and hands it on to later classes. A weather record of one's own, kept at home, almost always proves interesting.

QUESTIONS, EXERCISES, AND PROBLEMS

1. How has the weather ever served as a barrier to your movements in July? in January? in March? in April?

2. What relation has the wind to the fact that the best residential sections of many manufacturing cities of the United States lie in the western quarter of the city?

3. In which climatic zone would power from windmills be most reliable?

4. Trace a map of the Atlantic Ocean and insert the route of Columbus on his first voyage to and from America. Add arrows to show the direction of the winds in the climatic belts which he traversed. What relation was there between the winds and his success? Find out about the duration as well as the location of his return voyage and of later voyages, and determine the relation of these facts to the winds.

	A		B		C		D	
	Temp.	Precip.	Temp.	Precip.	Temp.	Precip.	Temp.	Precip.
January	30°	2.5 in.	74°	0.4 in.	60°	0.5 in.	78°	0.0 in.
February	31°	2.3	75°	0.6	63°	1.2	77°	0.0
March	40°	2.6	77°	1.0	68°	0.4	72°	0.5
April	50°	2.8	79°	1.5	75°	0.0	65°	1.4
May	58°	3.0	81°	2.5	80°	0.1	58°	3.0
June	68°	3.1	79°	8.0	83°	0.4	54°	4.2
July	72°	3.1	77°	15.0	85°	1.3	50°	4.5
August	71°	3.3	78°	11.0	84°	0.8	50°	3.2
September	66°	3.0	79°	6.0	82°	0.2	53°	2.5
October	55°	2.8	77°	4.0	75°	0.0	62°	1.0
November	42°	2.6	75°	1.5	68°	0.0	70°	0.2
December	35°	2.6	74°	1.0	64°	0.4	74°	0.0
Average	51°.5		77°.1		73°.9		63°.3	
Total		33.7 in.		52.5 in.		5.3 in.		20.5 in.

5. Discuss the probable seasonal changes throughout the year in the following latitudes on a globe entirely covered by the ocean: 10° N, 20° N, 30° S, 45° N, 60° S. Draw diagrams showing how the rainfall and temperature would vary from month to month in each latitude.

6. Draw diagrams illustrating the seasonal march of temperature and precipitation, that is, the conditions from month to month, in places having the temperature and precipitation shown in the table on the preceding page.

Locate each of these places in its approximate latitude on a globe covered entirely with water, and describe the temperature, pressure, winds, and rainfall of the zone in which it lies. For help in this use A87, A88, A92, A100, A101, and A107.

7. What would be the probable climatic conditions of your own home if the earth neither rotated nor revolved around the sun? What would be the probable result if the earth revolved around the sun but did not rotate?

8. Plot rainfall and temperature curves of four places of which you know the climate by experience. Give ten practical results of the seasonal changes of climate in these places.

9. In order to prepare for the study of climate in a later chapter, begin a weather record as indicated in Exercise 1, Chapter XVI. Also, secure copies of the daily weather map for the next three or four months. Study these to see whether you can detect any influences of continents and oceans.

CHAPTER VI

THE CLIMATE OF CONTINENTS AND OCEANS

A. The Effect of Land and Sea

How Oceans and Continents Influence Temperature

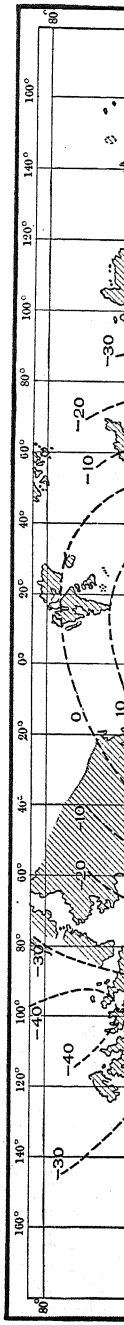
The simple arrangement of the climatic belts considered in the previous chapter and shown in A73 must now be modified to show the influences of (*a*) the distribution of land and sea, and (*b*) mountains and plains.

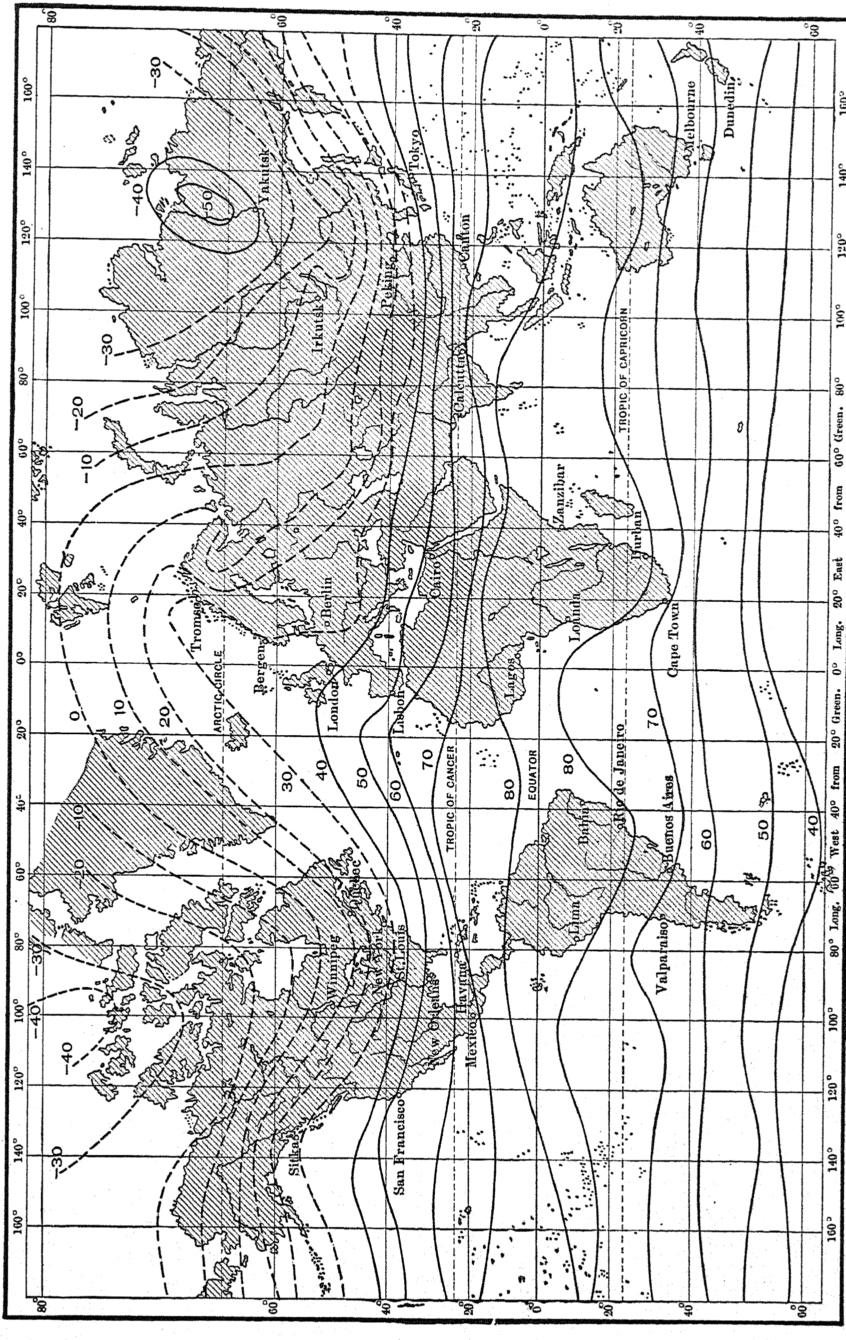
The land and the sea differ greatly in climate. Land, as we have seen, becomes hot under the sun's rays much more rapidly than does water, and likewise cools much more rapidly. This is evident to anyone who goes to the seashore either in summer or winter. In June a dweller in Minneapolis may leave his home at a temperature of 90° for a trip to Europe. Three days later in the same latitude on the Atlantic he may want his overcoat in a noon temperature of only 55°. The ocean water still retains something of the cold of winter.

It is not necessary to go so far, however, in order to note the contrast between land and sea. Often the summer air is cool and bracing close to the seashore, while ten miles inland it is hot and depressing. On the coast of central California at places such as Monterey people jokingly say that in summer they must go into the interior to get warm. The ocean is so cool and west winds blow from it so steadily that the thermometer stays between 55° and 70° even when there are temperatures above 100° one or two hundred miles away in the great interior valley, where the land has yielded to the influence of the hot summer sun.

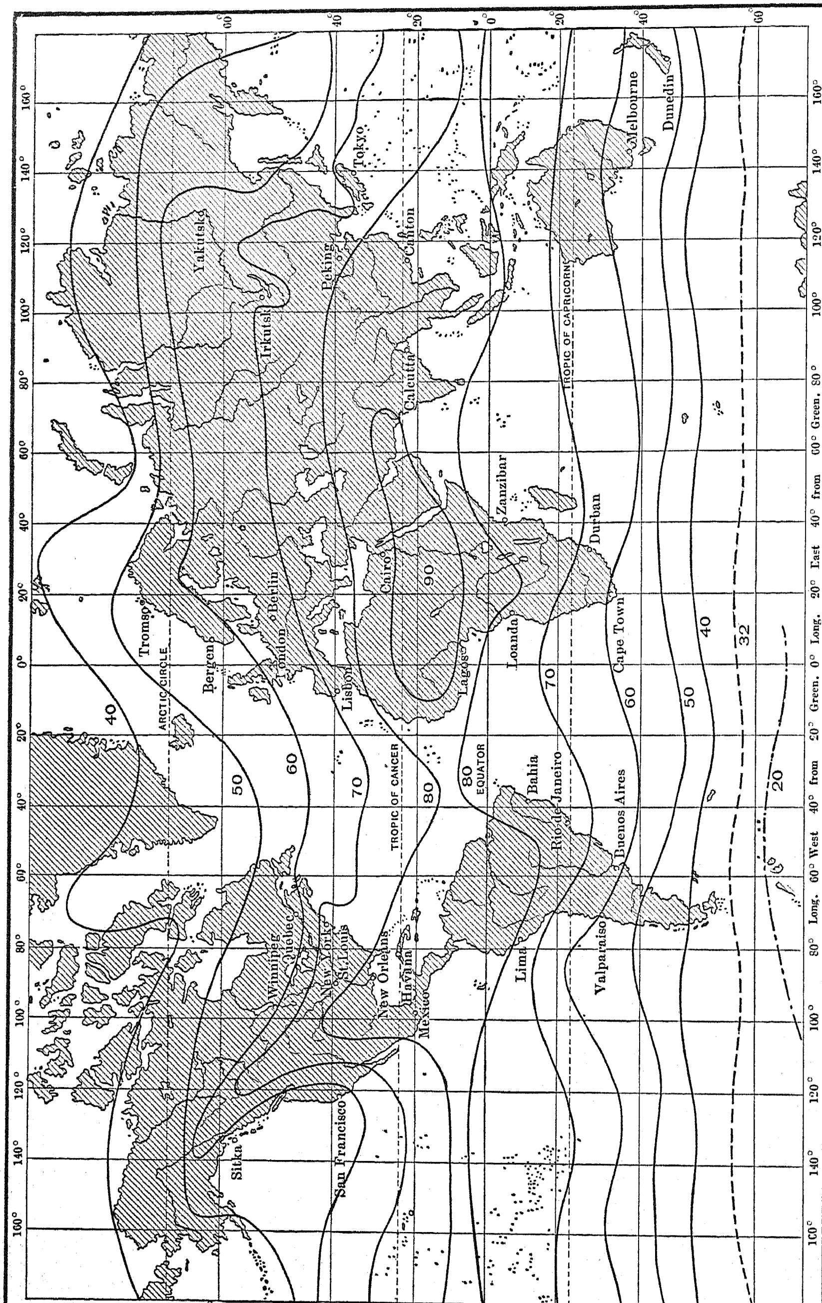
In the winter the contrast is the other way. A boy from central New York, for example, may leave his companions coasting on deep snow in January. At Boston in the same latitude, he may find bare ground and not even any skating. This is not because Boston has less precipitation than central New York, but because it lies on the seacoast and in winter is kept at a higher average temperature than the interior by occasional winds from the ocean.

Since the lands in summer become warmer than the oceans and in winter colder, the change from one season to the other must be greater on the continents than on the oceans. This is illustrated by a comparison





A—Mean Temperature of January. Reduced to sealevel.



- - - - indicates 32° and below

A.—Mean Temperature of July. Reduced to sealevel.

of A87 and A88, which show what the average temperatures would be in January and July if all the lands were at sealevel.

Marine versus Continental Climates

(1) *The Uniform Marine Climate of the Lofoten Islands.* Let us compare an extreme *marine* climate with an extreme continental climate in the same latitude. The southern Lofoten Islands off the coast of Norway, and Verkhoyansk, Oimekon, or some neighboring place in Siberia, probably furnish the greatest contrast to be found anywhere between places lying at equal distances from the equator. Both regions are just within the Arctic Circle. Yet in winter the winds blowing from the ocean prevent the Lofoten Islands from suffering the usual arctic severity of such latitudes. Grass remains green and cattle are pastured out of doors all the year. In summer, however, although the weather is milder than in winter, the temperature of the ocean is so nearly the same as in winter that the islands are raw and chilly. So cool is the air that practically no trees and crops will grow, and the people wear the same thick, warm woolen clothing, summer and winter alike. The great characteristic of the marine climate of the Lofotens is its uniformity.

(2) *The Extreme Range of the Continental Climate at Verkhoyansk.* Verkhoyansk is so different from the Lofoten Islands that one can scarcely believe that both places are in the same latitude and no farther apart than Portland, Maine, and Portland, Oregon. At the Siberian town the range from the average January temperature to the average of July is 120° F., whereas in the Lofotens it is only 20°. Near Verkhoyansk the temperature has been known to fall to 90° below zero. Almost every year it goes down to −70° or −80°. In fact, the average for the whole month of January is about −60°. It is so cold that a steel skate, so it is said, slips on the surface, because the friction of the skate on the ice does not melt the ice at all, and therefore the skate does not "take hold."

Strange as it may seem, the summer is warmer at Verkhoyansk than in the islands off the Norwegian coast. This, of course, is because the land of the continental interior warms quickly under the summer sun. The *average* temperature in July is 60°, or nearly as high as the *highest* ever known in the Lofotens, where the July average is only 51°. Temperatures as high as 85° have been recorded at Verkhoyansk, and 75° to 80° is common during the long days of summer. Hence some trees grow in spite of the intense cold, and crops can be raised, although none will grow on the Norwegian islands. To be sure, the ground never really thaws. If a man digs down a foot or so in his vegetable garden in July or August he comes to frozen soil, for only a thin layer on the surface ever melts.

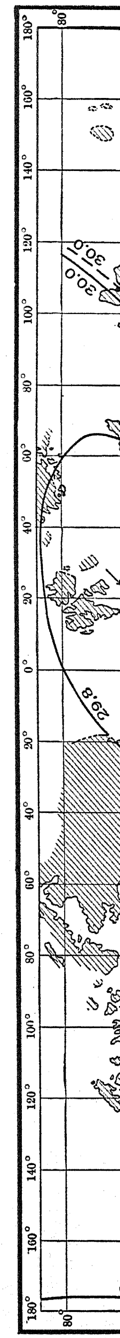
In a place like Verkhoyansk not only the changes from season to season but also those from day to night are often extreme. Out of doors on a March night one wants all the fur coats he can get, and even then one's nose may freeze during a short walk. The next noon, however, the warm sun and still air make it possible to chop wood with bare hands. By day in August light clothing is sufficient, but at night frosts may occur.

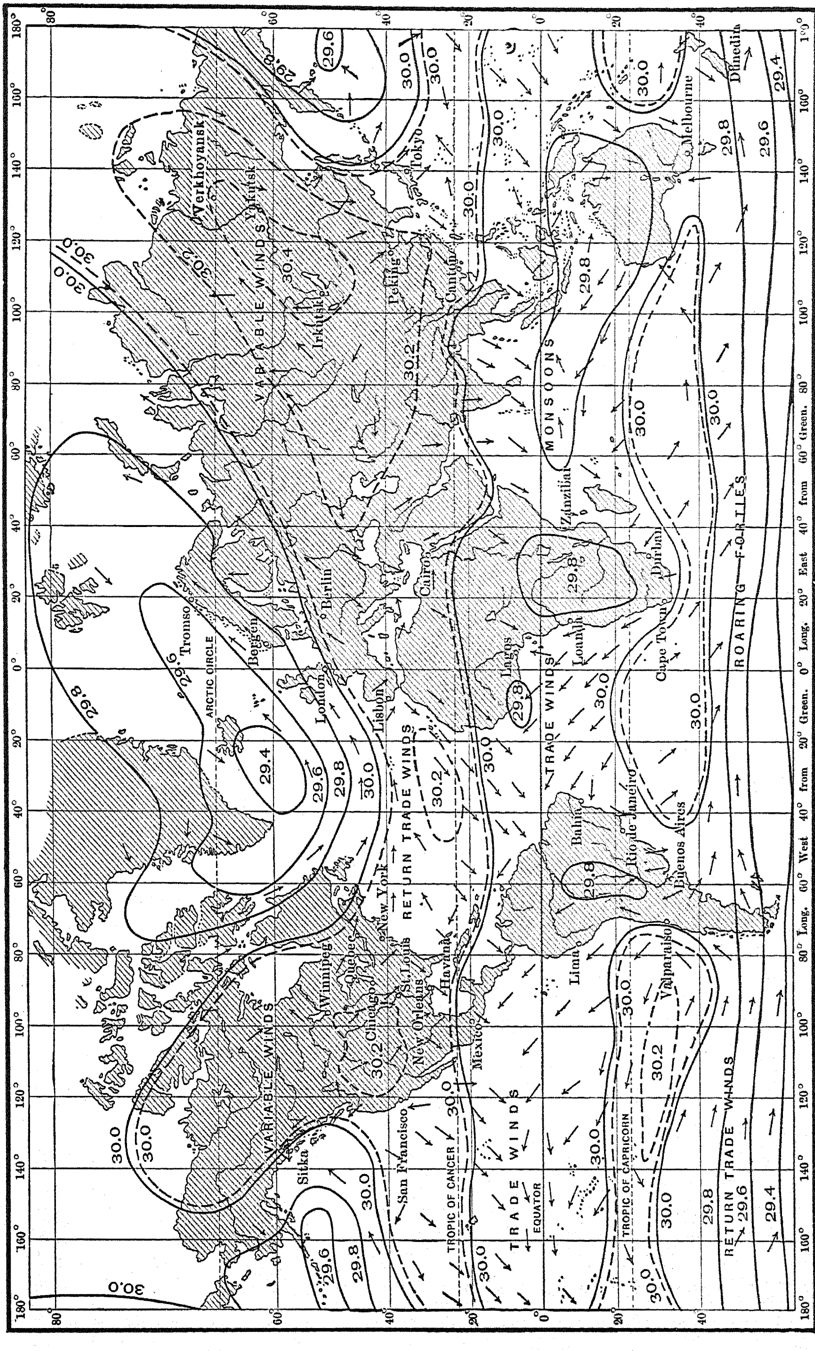
Verkhoyansk and the Lofoten Islands represent the extremes of continental and oceanic climates, but many other regions show somewhat similar conditions. In the typical continental climate the winter is long and cold, and the summer long and hot, with brief transition periods in fall and spring during which the change in temperature is rapid. The typical oceanic or marine climate has a mild winter and a cool summer, with no sharply marked transition seasons.

How Continents and Oceans Affect Pressure. Since the continents and oceans alter the distribution of temperature, they must also alter the atmospheric pressure. As the continents grow warm in summer the air expands. Therefore at high levels it flows away from the lands and accumulates over the cooler air of the oceans. This gives low pressure in summer over the lands and high over the oceans. The process is like that shown in A72 except that the interior of the continent takes the place of the equatorial belt, and the ocean that of the subtropical high-pressure belt. In winter the opposite occurs. The land becomes cold much faster than the oceans. Therefore the air over the lands contracts, while that over the water remains expanded. Accordingly, some of the upper air moves from the oceans to the lands. The result is low pressure in winter over the oceans and high pressure over the lands.

The growth of the continental areas of high or low pressure does not entirely wipe out the pressure belts that were described in connection with A73, but it greatly modifies them. Look at A91 and A92, which show the distribution of atmospheric pressure at sealevel in January and July. The dotted lines indicate high pressure and the solid lines low, with intermediate regions between them. In the January map notice how the northern subtropical belt of high pressure expands over the cool continents, while the southern belt is broken by the continents which are warm in the southern summer. In the July map the northern high-pressure belt is broken by the low-pressure areas over the warm continents, while in the cool southern hemisphere the belt is continuous.

How Winds Blow in Respect to Continents. The practical importance of changing areas of high and low pressure over continents and oceans lies largely in their effect on winds and rain. Since winds blow from areas of high pressure toward those of low, they tend to blow out-





—— indicates pressures below 30 inches
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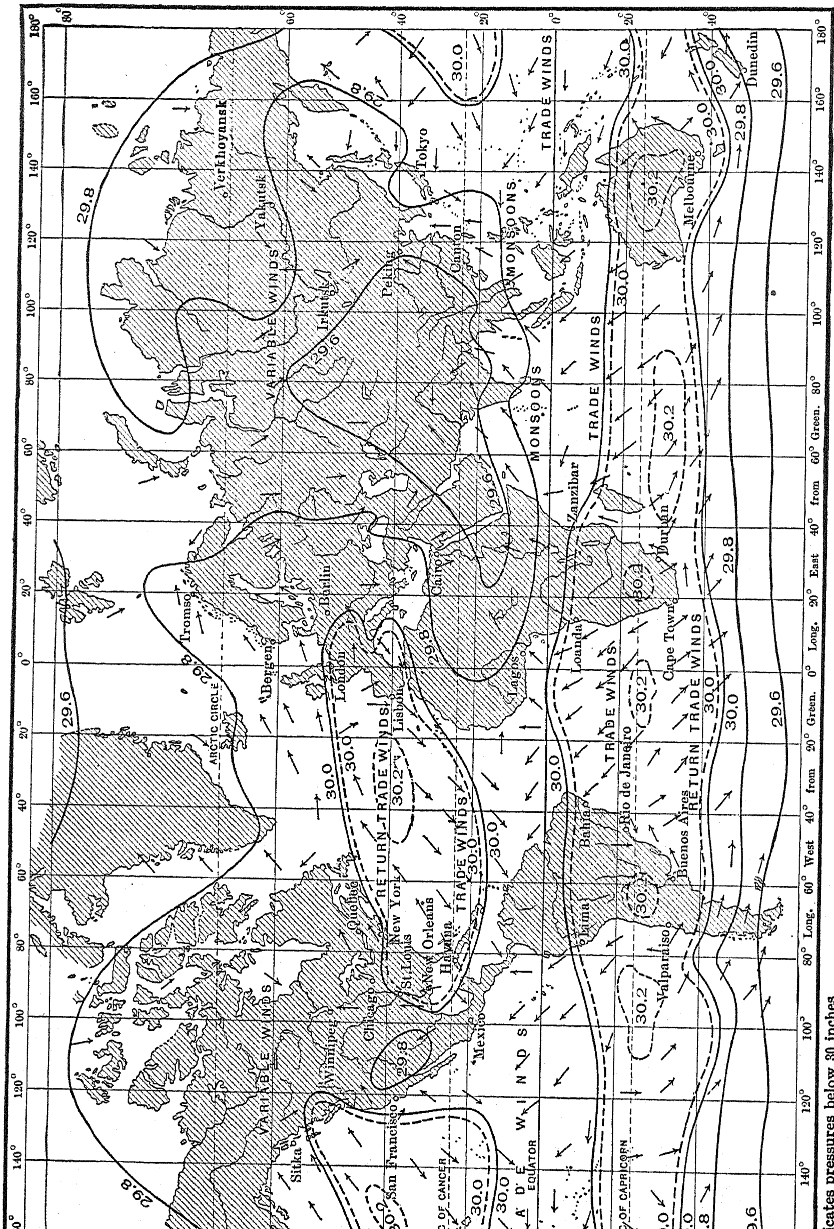
A—Pressure and Winds in January.



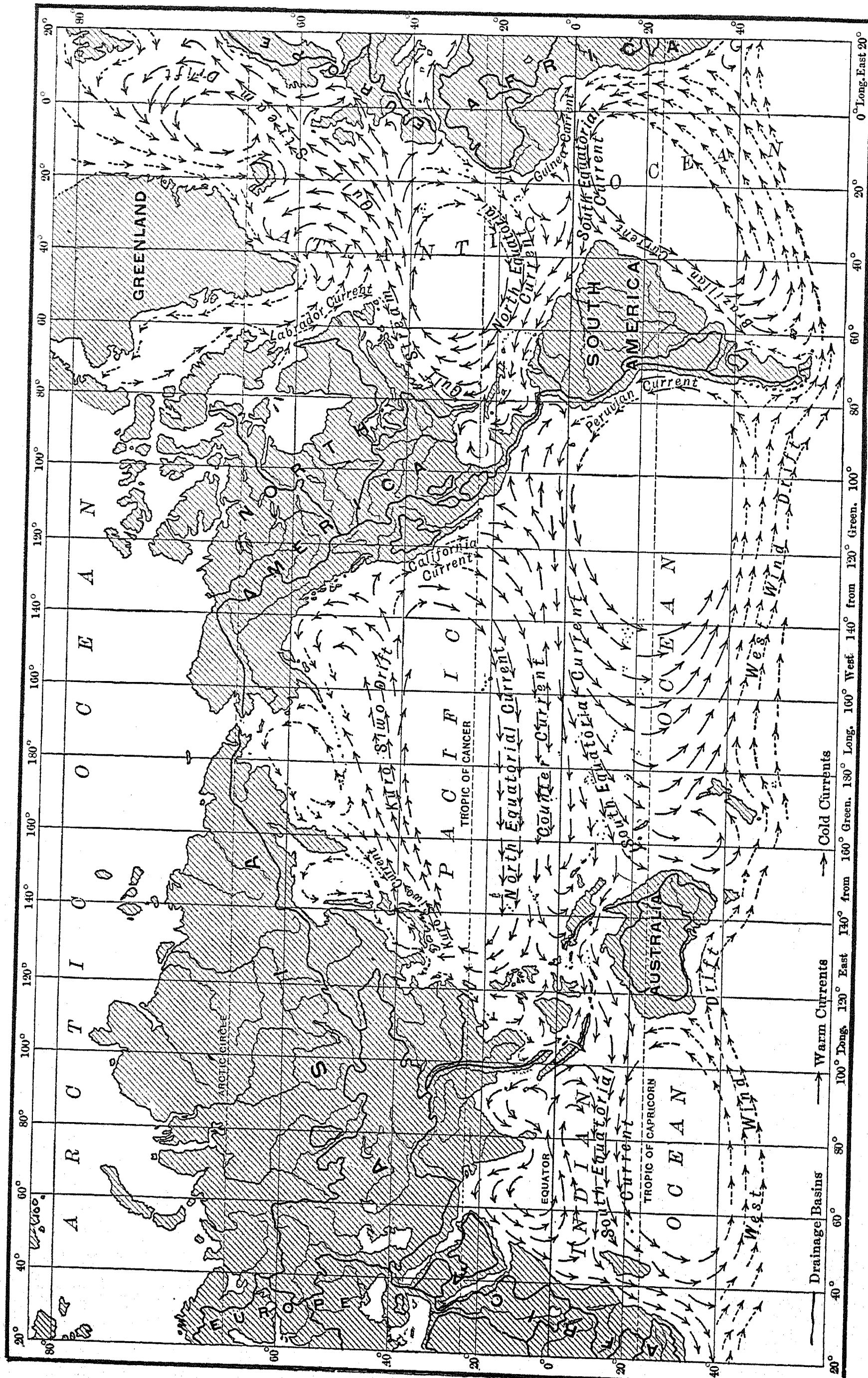
A—Pressure and Winds in July.

ward from the continents in winter and inward in summer. In A91 and A92 the arrows show how the winds blow during January and July. Of course the direction may change from day to day, but the average direction is what is here shown. Compare the two maps. In January the majority of the wind arrows point obliquely away from the high-pressure areas of the interior of the northern continents. In July the arrows point similarly inward toward the areas of low pressure in the northern continents. Thus in winter the cold dry air of the continental interior blows outward, whereas in summer the moist and relatively cool air of the oceans blows inward. These outflowing winter winds and inflowing summer winds are strongest in Asia because of its great size and its location in a latitude where the contrast between summer and winter is extreme. They are weak in Africa in spite of the size, for that continent lies largely within the tropics.

Winds and Ocean Currents

The movement of the winds causes a corresponding movement of the ocean waters. The currents thus formed carry ships out of their courses when the sky is cloudy and the true position cannot be determined. During both World Wars they spread explosive mines far and wide to the great danger of shipping. Since the trades are the steadiest winds, they cause the strongest movements. On each side of the equator the tradewinds blow the surface water westward, causing what are known as the equatorial currents. If there were no continents these would combine so that one broad continuous current would pass completely around the world. The continents, however, deflect the currents either northward or southward. In A94 notice that Cape Saint Roque in South America divides the southern half of the Atlantic equatorial current into two parts. One goes southward as the Brazil Current, while the other joins the northern equatorial current and swings around northward into the Gulf of Mexico.

Where the equatorial current comes out from the Gulf of Mexico between Florida and Cuba it begins to be known as the Gulf Stream. It is the strongest great ocean current that we know of, the only one that moves like a great river. In the Straits of Florida it has a depth of 2,000 to 3,000 feet, a width of about 40 miles in the narrowest part, and a velocity of nearly 5 miles an hour. As it comes out into the main Atlantic, however, it quickly loses its riverlike quality and spreads into a broad shallow sheet which moves more and more slowly until its rate is only half a mile an hour. There it is joined by other warm equatorial water which has swung to the right from the tradewind current before reaching the Gulf of Mexico. Although the Gulf Stream keeps



A—Ocean Currents and Drainage Basins.

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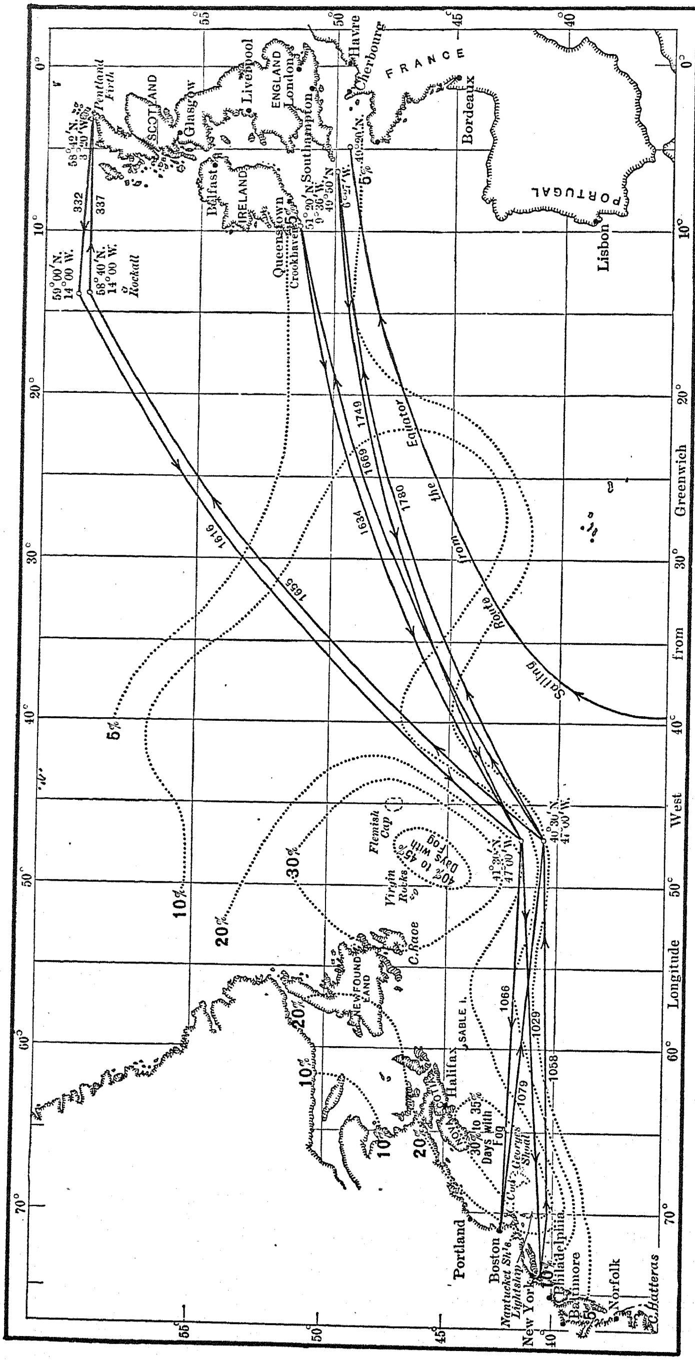
away from the immediate coast of the United States, its influence can be felt as far north as Cape Cod. Because of its presence the water on the south side of that cape is distinctly warmer than on the north, which makes quite a difference to summer visitors. When vessels sail from New York to Europe the passengers can easily detect the entrance of their ship into the Gulf Stream. The air becomes warmer, the water changes color, and jellyfish and other forms of life become more abundant.

How the Atlantic Drift Modifies the Climate of Europe. As the Gulf Stream is driven eastward by the prevailing westerlies it spreads out to a breadth of hundreds of miles and becomes the Atlantic "Drift." On the eastern side of the Atlantic a part of the current turns south and finally rejoins the equatorial current, while part passes northeastward to the Arctic Ocean past Norway. In the North Atlantic the Drift spreads over the ocean's surface so widely that in winter the winds blowing from the Atlantic Ocean to Europe are much warmed, for they absorb some of the heat brought by the current from equatorial regions. Hence the winter winds blowing from the Atlantic Ocean to Europe are warmer than those blowing from the Pacific to our own continent. This is one reason why the most progressive and populous parts of Europe are about 10°, or 700 miles, farther north than the corresponding parts of North America. It must be remembered, however, that the westerly winds from the North Atlantic would give Western Europe a decidedly warmer climate than Labrador even though there were no warm ocean current in the Atlantic.

The Effect of the Cold Labrador Current. Since the Gulf Drift pours part of its waters into the Arctic Ocean, a return current is caused. This cold Arctic Current creeps along the eastern coast of Greenland to Labrador and thence to New England. The Labrador Current, as it is called, is of considerable influence in causing the east winds of New England to be cool and raw. Its presence explains why sea-bathing is so much less common at the summer resorts of Maine than on the south shore of Cape Cod, for example.

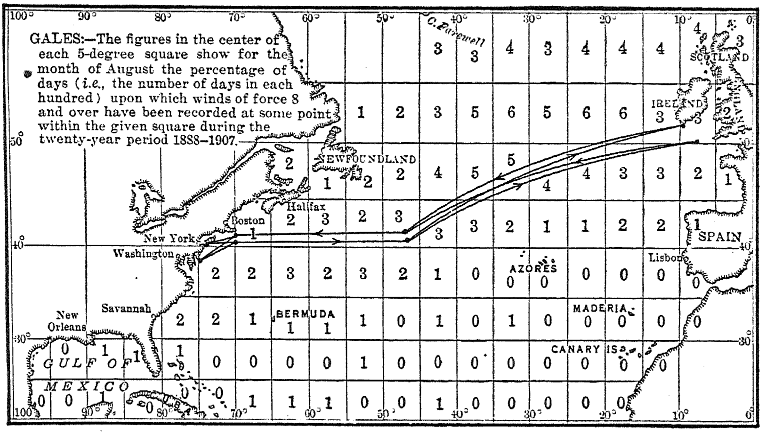
It also explains the fogs in which the fishermen on the Grand Banks of Newfoundland are sometimes lost and perish. When south winds reach the Labrador Current they are cooled so much that their moisture condenses. This causes frequent fogs not only on the Grand Banks of Newfoundland, but along the coasts of Maine and Nova Scotia. The dangers of the Grand Banks are increased by icebergs. The Labrador Current brings great "mountains of ice" southward from Davis Strait, where they have broken away from the ends of huge glaciers that flow down through deep valleys on the side of the high plateau of Greenland. Not only are the icebergs dangerous in themselves, but their low tem-



A—North Atlantic Sailing Chart for August. Fog. Dotted lines show percentage of days on which fog is normally observed. Numbers beside lines indicate distances in miles.

perature increases the fog. A96 is the official sailing chart of the North Atlantic for August. Notice how many foggy days occur near the Grand Banks. The dangers there are so great that, since the *Titanic* was sunk by hitting an iceberg in 1912, the great North Atlantic trade route has been lengthened a little to carry it south of the Banks.

The Oceanic Whirls. Each of the other oceans, like the Atlantic, has a series of currents which are kept circling around by the prevailing winds. The equatorial part of the Pacific whirl, as it may be called, is deflected northward like that of the Atlantic, but not to so great an extent. Nevertheless, the equatorial waters flowing northward along the east coast of Asia warm the winds sufficiently to make the east side of Japan distinctly warmer than the northwest side, just as the south shore



A—North Atlantic Sailing Chart for August.—Gales.

of Cape Cod is warmer than the north. Even in Alaska the effect of the warming of the water in distant equatorial regions can be felt in the fact that on the south coast the harbors are free from ice in winter. Sitka, in latitude 57° N, but with a marine climate, has the same January temperature (32° F.) as continental Cincinnati, 28° farther south. In July, however, Sitka, with an average temperature of 55°, is 22° cooler than Cincinnati.

In the southern hemisphere the whirls of the ocean currents go in the opposite direction from those of the northern hemisphere. This is because the winds, as we have seen, are deflected to the right in the north and the left in the south. Beyond the southern limit of the whirls an almost unbroken current flows eastward encircling Antarctica. It adds its effect to that of the "roaring forties," as the westerlies are called, in

making navigation difficult in one direction but easy in the other. Captains of sailing vessels who have to navigate in this region often prefer to go two or three thousand miles extra and travel around the world with the winds and currents rather than take a shorter course against them.

The Indian Ocean has currents like those of the larger oceans. In that region, however, the monsoon winds blow in opposite directions in different seasons, and the currents are correspondingly reversed.

The Effect of Continents on Rainfall

Why Continental Interiors Have a Rainy Season in Summer. The movement of the air, as we have already seen, determines how much rain a given place shall receive. In summer when the continents form warm areas of low pressure and inblowing winds, much moisture is brought inland from the oceans. As the moisture-laden air approaches the center of low pressure it gradually rises and finally produces clouds and rain. Notice how much larger the dark areas are in A100, showing summer rain, than those in A101, showing winter rain. This is especially noticeable in low latitudes which are reached by the equatorial rain belt, and on the east sides of the continents in middle latitudes. Much more rain also falls in summer than in winter in the interiors of North America and Eurasia in these same latitudes, but the scale of the maps does not make this sufficiently evident. Only in a few regions, such as the west sides of the continents in middle latitudes, is winter rain more abundant than summer rain.

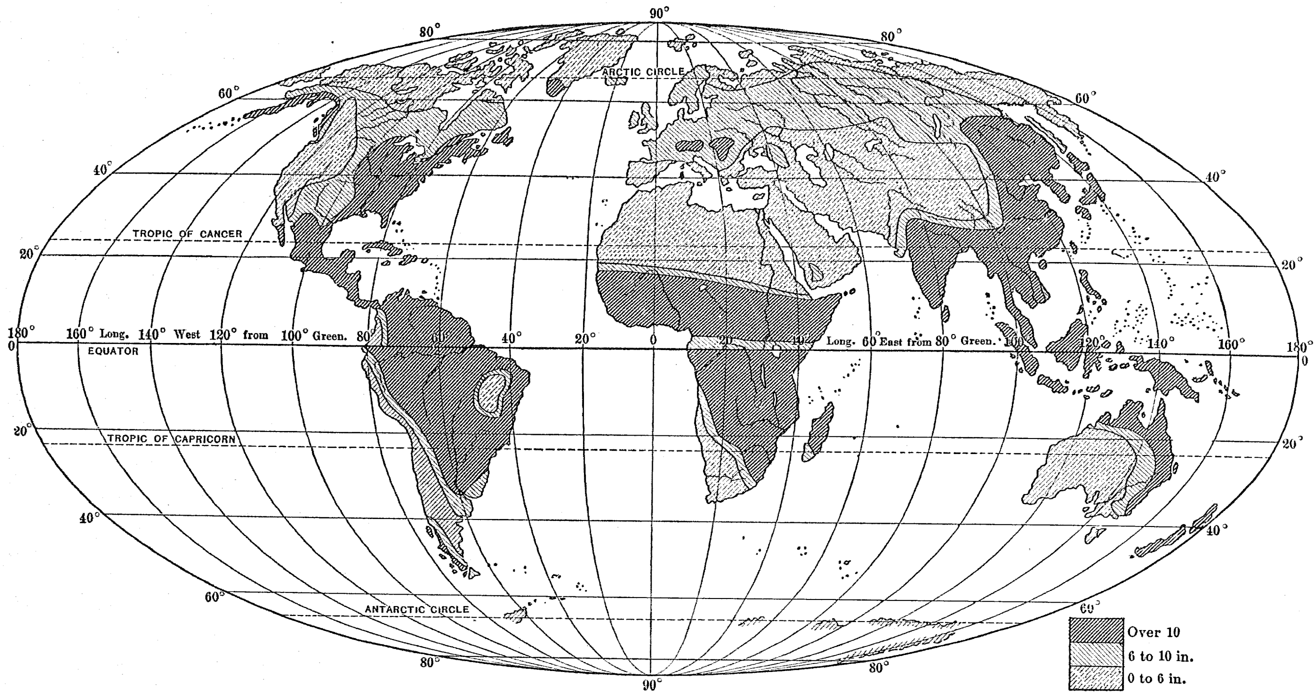
Because continental interiors receive more rain in summer than at any other season, central Kansas, for example, gets 16 inches of rain in the six months from April to September and only 4 during the other six months. If the Kansas rainfall were evenly distributed throughout the year it would not be enough for reliable agriculture. Luckily the continental low pressure causes the winds to blow toward the interior more strongly in summer than at any other season, and hence as far west as central Kansas the crops are usually well watered. In winter, on the other hand, the low temperature, high pressure, and outblowing winds cause the interiors of the continents to be dry. Thus though the Dakotas are much colder than New York State in winter, they have far less snow. This is an advantage in some ways. It permits cattle to pasture all winter, and in the spring the ground is not covered with a layer of snow which delays the melting of the frost and thus prevents early plowing and planting. It is a disadvantage because in the spring and fall it makes the ground too dry for trees and often for crops. This is the main reason why the average yield of wheat per acre in the Dakotas, or Russia, for

example, is only about half as much as in Maine, even though the soils of Maine are poorer.

The Great Seasonal Contrasts of Asia: Monsoons. The most extreme effect of a continent upon winds and rainfall is seen in Asia. Because of the great size of Asia the extreme difference between the highest temperature in summer and the lowest in winter may amount to 175° in Siberia north of the Arctic Circle, and to 100° even in southern Persia and western India. The differences between the low pressure of summer and the high pressure of winter are correspondingly extreme. The variations of pressure naturally give rise to strong inblowing winds in summer and outblowing winds in winter. These are best developed in India and are called monsoons. In A91 one sees that in January the winds in the southern half of Asia blow in general from a northerly quarter. Since they come from the dry interior there is practically no winter rain in large parts of India and China. In spring when Asia grows hot and the high pressure of the interior gives place to low, the outblowing winds weaken and are replaced by irregular winds and calms. Then the air begins to move in from the ocean, and soon strong south or southwest winds are established. In the July map the arrows point in almost the opposite direction from those of January, and the winds of southern Asia blow inward (A92).

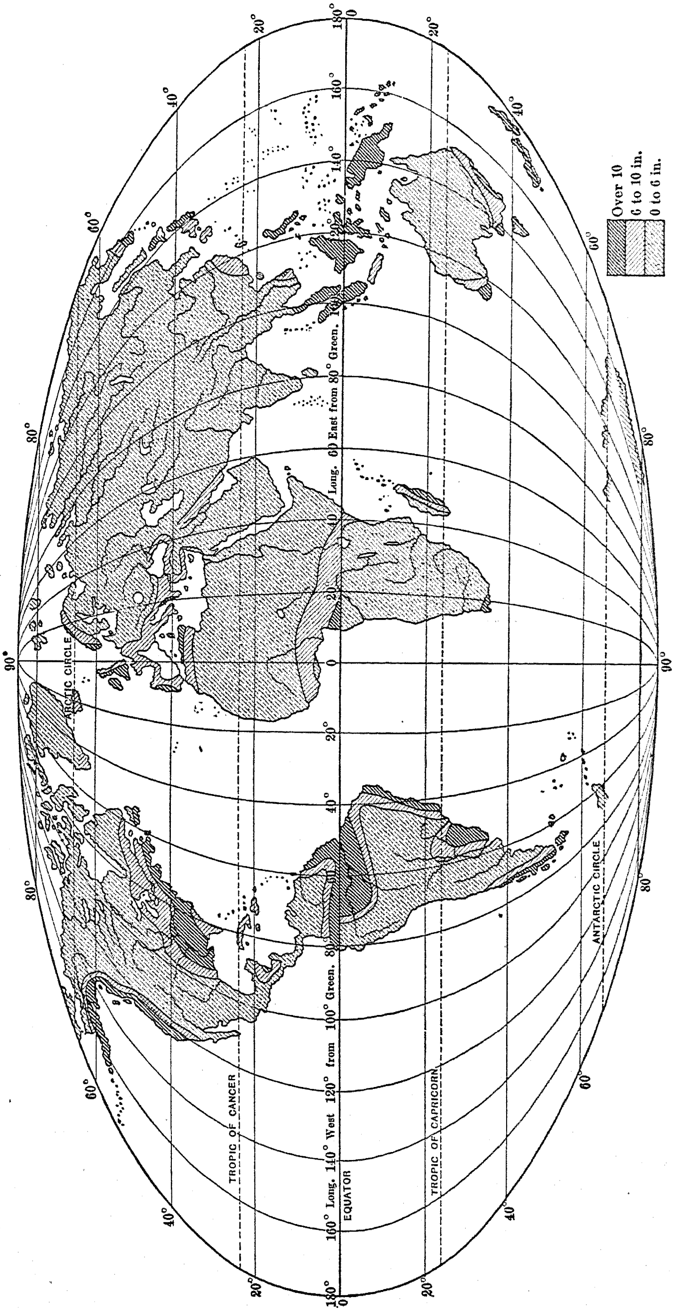
In India the alternation between the northeast monsoon in winter and the southwest monsoon in summer is remarkably regular. The people count upon this regularity so much that formerly, when crude sailing vessels were the chief carriers of commerce, native boats from India used to sail to Zanzibar and the African coast each winter with the northeast monsoon at their backs. Then they spent several months in trading or in idleness. Finally, when the southwest monsoon was well established, and the wind blew strongly toward India, they merrily came back, with the breeze as favorable as on the outward voyage. Before the building of the Suez Canal the sailing ships that went from England to India also planned their voyages so as to take advantage of the winds in both directions. Even now the natives of the coral islands west of India depend on the monsoons to take them to the mainland and back again. Their sailing boats are so primitive that they cannot make headway against a wind.

How the Southwest Monsoons Bring Prosperity and Health. The most important effect of the monsoons is the rain. In winter only the southern tip of India gets much rain, for that is the only part of the country where the northeast trades blow from the sea to the land. Elsewhere, because the country lies in the Wet and Dry Low Latitudes, drought prevails month after month and the people long for the summer



A—Summer Rainfall. June to August North of Equator—December to February South of Equator.

Note that this map and the next one each cover only three months. In most parts of the world, especially (1) in low latitudes, (2) on east coasts, and (3) in continental interiors, the summer rainfall is decidedly greater than that of winter. Adapted from Supan.



A—Winter Rainfall. December to February North of Equator—June to August South of Equator. Adapted from Supan.

monsoon. Before it comes the air is burning hot, the ground is parched, and almost nothing will grow. Then the southwest wind begins to blow, the clouds gather, the sky is full of lightning, the thunder crashes, rain falls, the air is cooled, and except in the Indus desert the land is ready for the seed. The people welcome the rains with feasting and rejoicing, for their timely coming usually gives promise of good crops. Contrary to the usual belief, the first effect of the summer monsoon rains is to restore the health of the sick, check epidemics, and bring the most healthful part of the year. Later, when the wind becomes weak, but rain still falls heavily, the air becomes muggy and oppressive.

B. The Effect of Relief

Four Ways in which Relief Affects Climate

(1) *How relief Influences Temperature.* The effect of relief upon the four climatic elements—temperature, pressure, winds, and rain—is more easily seen than the effect of land and sea. Almost everyone knows that the temperature changes from the base of a mountain to its top. At the base in a tropical country the air may be so warm that the lower slopes are shrouded in tree ferns, graceful palms, twining creepers, and other tropical growths. Higher up the vegetation consists of the broad-leaved trees of the temperate zone. At the top the air is so cold that wastes of naked rock lie close to perpetual snow, like that which enshrouds the higher Andes even at the equator.

In tropical lands the temperature becomes more and more favorable to human activity up to a height of about 7,000 feet or more. Only at such altitudes does the air gain something of the stimulating quality which is so beneficial to health and energy in temperate lands. This is shown in the location of the capitals of the Latin American republics. Most of them are at altitudes of 5,000 to 10,000 feet, Mexico City, for example, being over 7,000. Even Brazil has decided at some time to remove the capital from beautiful Rio de Janeiro to the interior on the Brazilian plateau. Similarly the summer resorts, recreation centers, and sanatoriums for white people in India are "hill stations" at high altitudes. São Paulo, though only a little more than 2,000 feet above sealevel, is just enough cooler than Rio de Janeiro to have a distinctly more bracing climate. This helps to make its people more vigorous than those of the capital. Such vigor has joined with the surrounding coffee plantations in bringing prosperity and very rapid growth to São Paulo, and in making that city a center of revolutions as well as of local manufacturing. Simla, among the Himalayas, 7,500 feet above the sea, is becoming more and more

fully the summer capital of India. In the Philippines during the period of American rule the hill station of Baguio has assumed a similar importance. Without it many American officials and their families would have been forced to leave the islands in order to recover their health.

In high latitudes, on the contrary, the highlands are usually too cold to support many people. In Norway, for example, the central highland is inhabited only by a few Lapps in the north and a few cattle-keeping Norwegians in the south.

(2) *Relief and Atmospheric Pressure.* The effect of relief upon atmospheric pressure is felt directly in the difficulty experienced in breathing at high altitudes. It is also evident in changes of temperature and rainfall as one ascends. Up to a height of about 5,000 feet the decreasing density of the air, that is, the diminishing atmospheric pressure, does not incommode the ordinary healthy person. Yet even at that height the person who runs or plays tennis often gets out of breath more speedily than at sealevel. At 10,000 feet the air is so rare that, unless people have been born to it, they usually find that the effort to get enough oxygen from the rarefied air imposes a harmful strain upon the heart. At still higher elevations human activity is much curtailed. Many lowlanders suffer from mountain sickness, *soroche,* on first climbing so high, and never are so vigorous as they are when lower down, even though they seem to be acclimated. People who live permanently at such altitudes generally have enlarged hearts and lungs. Nevertheless, when they climb an additional 5,000 feet they, too, often suffer as badly as lowlanders. The rarity of the air and the consequent lack of oxygen have been more potent than anything else in preventing one expedition after another from reaching the top of Mount Everest.

Low temperature, as we have seen, also plays its part in keeping people out of high mountains. When air rises and expands, because the pressure upon it diminishes, it cools at a definite rate. This *adiabatic* cooling is responsible not only for the low temperature at high altitudes, but also for the striking contrasts between the rainfall of different portions of a mountain range. We shall return to this in a moment.

(3) *How Relief Changes the Course of the Winds.* One of the most important ways in which relief influences climate is through movements of the air. This is because highlands, mountain ranges, and valleys often change the direction of currents of air, and prevent certain winds from blowing in protected places. For instance, one of the authors of this book has had the experience of climbing a high mountain pass in almost absolutely still air, only to emerge into a violent gale when the top was at last reached. He has pitched his tent in still air at the mouth of a mountain valley only to be awakened later by a roaring gale which overturned

the tent. In the first case the lee side of the mountain was protected from the fierce wind of the other side. In the second, the air which became cool by contact with the mountain sides at night drained down from the side valleys like water. In the main valley it united into a river of cool air which took the form of a gale. In many valleys the direction of the ordinary winds is altered so that the air rarely moves in any direction except up or down the valley.

Another noteworthy effect of mountains upon winds is seen in the difference of temperature of the same wind before and after it crosses a mountain. As moist air rises it cools adiabatically, as we have just seen, and therefore gives up rain. But when the atmospheric humidity changes from invisible vapor to water in the form of tiny droplets in clouds or fog, it gives up a great deal of heat—latent heat, as it is called. Accordingly, the air does not grow cold so fast as the adiabatic rate would lead one to expect. If strong winds bring such air down on the other side of the mountains it becomes warm again at the adiabatic rate. Hence, when it reaches its original level, it is warmer than when it started. In winter, at the eastern base of the Rocky Mountains, "chinook" winds of this nature, or foehn winds, as they are called in the Alps, sometimes raise the temperature from zero to 40° in 15 minutes. They may be so warm and dry that they almost lick up the snow, evaporating it as soon as it is melted so that it does not moisten the ground.

Examples of the Effect of Relief on Climate

(1) *The Riviera.* The Riviera is the narrow and rugged strip of coast on which are located Nice in southern France, and Genoa in Italy. The Maritime Alps and the Apennine Range shut out the cold north winds, or warm them in the way just described. The Mediterranean Sea is always warm because the Strait of Gibraltar is too narrow and shallow to permit currents of cold water to enter from the Atlantic Ocean. Hence the Riviera coast north of the Gulf of Genoa rarely experiences frost even in January, while at Portland, Maine, in the same latitude, the ground is sometimes covered with snow for five solid months. The Swiss and Italian Alps in similar fashion protect the Italian Lake region, where Lakes Maggiore, Como, and Garda are famous for their beauty. At their northern ends the lakes are hemmed in by lofty, precipitous mountains. At the south, where they are dammed by huge moraines of ancient glaciers, their lapping waves break against a mildly rolling hospitable land of farms and homes and pleasant prosperity. Near the lakes, as well as in the Riviera, lemons and olives grow in the latitude of Buffalo, or even St. Paul and Minneapolis. The mild winters and beautiful scenery of both the Riviera and the Lake region attract pleasure seekers and

invalids from all over Europe. The presence of a great number of people with plenty of money and nothing to do has caused Monte Carlo, in the little principality of Monaco, to become the most famous gambling resort in the world. All these results are due largely to the fact that the Alps, by shutting off the winds from the north, prevent cold waves like those which in our own country sweep across the plains and sometimes kill the orange trees even as far south as Florida.

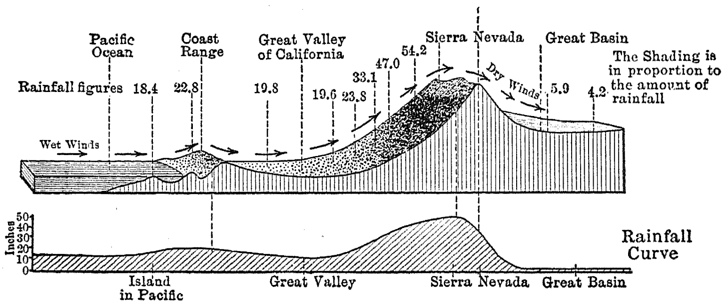
(2) *India versus China.* The Himalayas in the same way cause northern India to be warmer than the parts of China in the same latitude. For instance, Delhi, the capital of India on the Jumna, lies in about the same latitude as Hankow, the commercial center of China on the Yangtze, but its January temperature averages 58° while that of Hankow is 39°.

(3) *How Relief Permits Orange Growing in Northern California.* The effect of relief upon movements of the air and thus upon temperature can be seen both in great contrasts like that between India and China, and in small contrasts between places only a few miles apart. In California at the western base of the Sierra Nevadas in a latitude as far north as Philadelphia, oranges ripen in many small valleys, although in other valleys close at hand they will not ripen at all. In fact the oranges ripen earlier in some of these northern valleys than in the region around Los Angeles, 400 miles farther south. All the various reasons for this are connected with the form of the earth's surface: (1) The valleys face the southwest and thus receive abundant warm sunshine. (2) They are protected from cold winter winds from the interior by the high Sierras immediately to the east. (3) When air grows cool at night it contracts and therefore becomes comparatively heavy. Hence, instead of remaining in these valleys and becoming so cool that frost occurs, the air drains away because of the relief. Its place is taken by air which has not yet come in contact with the cool earth and hence still remains comparatively warm. Where the slopes are favorable there may be no frost, although ice forms not far away in the hollows where the cold air comes to rest. Wherever there is danger of frost, wise farmers take advantage of air drainage if their farms are on slopes. They plant their peach and apple orchards, for example, on the warmest slopes where late spring frosts will not nip the blossoms.

We have already seen that the effect of relief upon movements of the air and thus upon temperature is so common that most people have noticed it. At night, for instance, one feels chilly in a hollow, and then is surprised on climbing a hill to find the temperature warm and comfortable.

(4) *How Relief Influences Rainfall.* (*a*) THE EXAMPLE OF CALIFORNIA. Aside from cyclonic storms and the great equatorial belt of low pressure,

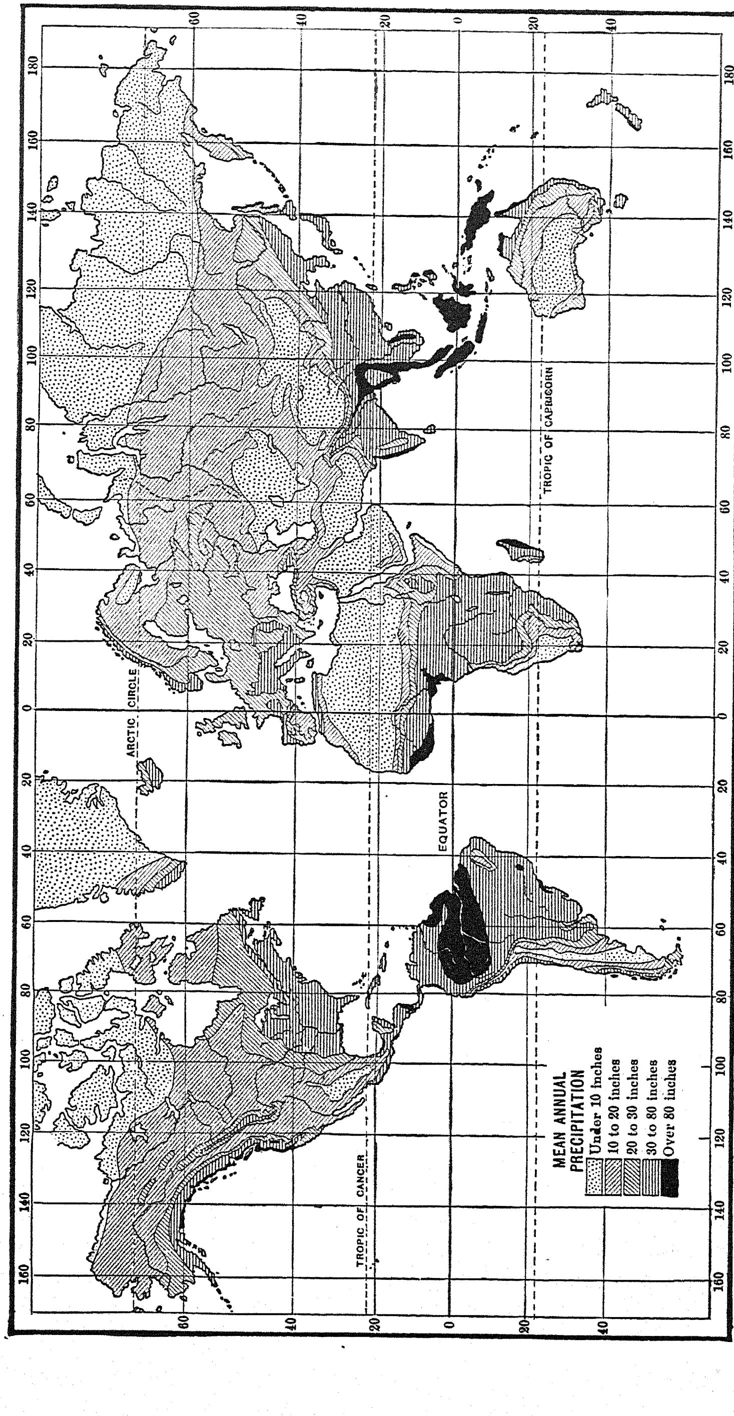
the relief of the lands is the chief cause of rainfall. When a wind reaches a mountainous region the slopes force it to rise. As we have seen in the equatorial belt of low pressure and elsewhere, rising air expands, cools, and loses part of its capacity to hold moisture. Hence clouds form, and rain or snow falls (A72). A good example is seen in the western United States. The upper part of A106 shows the altitude of the land from the Pacific Ocean eastward to central Nevada. Where the westerly winds, laden with water from the Pacific Ocean, strike the low hills at San Francisco, the rainfall (lower diagram) increases from 18 inches to 23, for the air rises and grows cool. Beyond the hills the rainfall decreases a little, but on the slope of the Sierras, where the air once more ascends, it increases rapidly to more than 50 inches. Still higher the rainfall diminishes again, as is usual on the windward slopes of high mountains. This is because cool air is less capable of holding moisture than warmer



A—Effect of Relief on Rain.

air. Hence a drop of temperature from 50° to 40°, let us say, causes much less precipitation than a drop from 70° to 60°, provided the percentage of humidity at the start is the same in both cases. Beyond the mountains part of the air descends the eastern slope. The descent compresses and warms it, so that its capacity for moisture increases and it sucks up moisture instead of giving it out. Hence at the eastern base of the Sierras there would be practically no rainfall were it not for occasional cyclonic storms which raise the air to high levels. Thus Reno gets 6 inches of rain and Wadsworth a little over 4.

Regions such as Nevada, lying to the leeward of mountains and sheltered from rain-bearing winds, are said to be in the "rainshadow." Places in a rainshadow get little rain, just as places in an ordinary shadow get little sunlight. The rainshadow often causes deserts where scraggly little bushes at wide intervals replace the splendid forests which lie at the same altitude on the windward side.



A—Annual Rainfall.

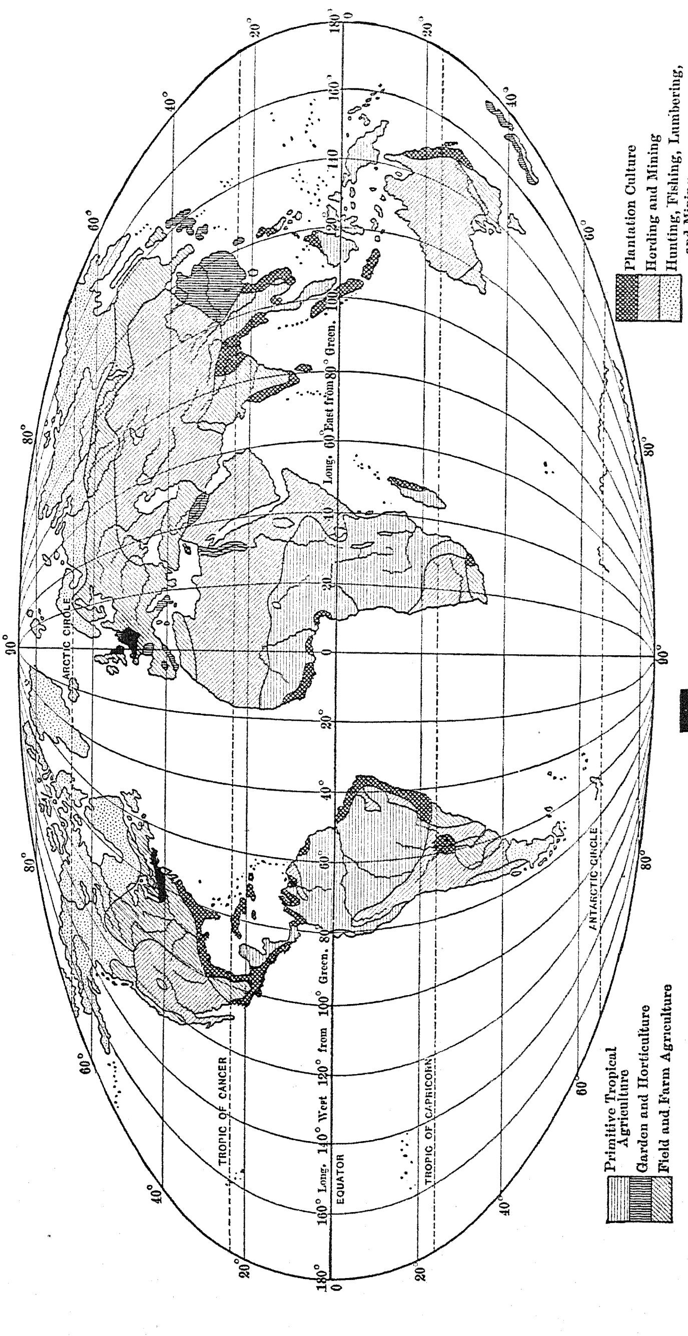
(*b*) WONDERFUL EFFECT OF HIMALAYAN FOOTHILLS ON RAINFALL. The Khasi Hills, a hundred miles south of the eastern Himalayas, furnish a remarkable example of the effect of mountains on rain. The southerly monsoon winds from the Bay of Bengal 200 miles away bring an abundant supply of water which is deposited as the air rises over the lower slopes of the Khasi Hills, which are really mountains. At Cherrapunji, 4,000 feet above the sea and 300 miles northeast of Calcutta, the average annual rainfall is 466 inches. Compare this with the United States east of the Mississippi where the average is only a little over 40 inches.

In 1861 the enormous amount of 918 inches, or 76½ feet, actually fell at Cherrapunji. More than a third of this (372 inches) fell in July alone, and 42½ inches in one day. As much rain in one day as most Americans see in a year! The heavy rains wash the soil from the slopes and leave naked rock, practically bare of vegetation. Yet in the flat places there is a perfect tangle of trees and vines, and plants grow as much in a month as they do with us in a year, for even during the rainy period there is some sunshine almost every day.

On their north side the Khasi Hills produce a rainshadow so that the precipitation promptly falls to 43 inches. Beyond this the rainfall again increases on the lower slopes of the Himalayas, only to decline once more at high altitudes. There the air has lost so much moisture that it cannot give up much. On this Himalayan slope, as is usual on the windward slope of a mountain, the rainfall increases only up to a certain level after which it decreases. Beyond the Himalayas the air has been so robbed of moisture that vast regions in central Asia are deserts. They lie in the world's greatest rainshadow.

Climatic Differences in Small Areas

We are apt to think of climate as something which varies only in large areas, but actually there may be different climates within 100 feet of one another. If you doubt this, examine the plants on the two sides of your own house or of some other where one side practically never gets sunlight and the other gets practically all there is. In the spring the grass on the north side may still be brown and the ground frozen when the grass on the other side is green. Tulips will blossom several weeks earlier on the sunny side than on the other. If nature is allowed a free hand, the difference between the kinds of plants on the two sides will be as great as the difference between average spots hundreds of miles north or south of one another. Every farmer knows that crops on a slope that faces northward mature later and are in less danger of drought than those on south slopes. Many know also that peaches, for example, will



A—Modes of Life.
Adapted from *Bartholomew*.

grow well on a southwestern slope, but may be nipped by early frost on level land, and may not grow at all on a northeast slope.

A windbreak also creates a small area with a local climate different from that of open fields not protected by trees. In the drier plains of the United States the crops within 100 feet or so of the lee side of a thick row of trees often grow much better than those farther away, or on the windward side. The trees check the dry, continental winds which dry up the crops and ruin them when rain is scarce. The fact that trees thus create a local climate explains why the United States government has experimented with a Shelter Belt composed of lines of trees extending many miles from north to south on the border of the agricultural part of the Great Plains. There the protection afforded by such trees, provided they are placed in bands close enough together and can be made to grow to sufficient size, may make all the difference between crop failure and a crop that is at least worth reaping.

Many other kinds of local climatic differences can be observed almost anywhere. Some street corners in cities are windy most of the time. In certain protected spots around our houses, or on the sides of the hills, the flowers bloom earlier or later than anywhere else. One of the authors of this book lives on a hill about three miles from his office. Sometimes, on telephoning home, he has found that snow is falling there, although it is raining where he is. Again, the direction of the wind is often altered by valleys. In almost any deep valley, and in many shallow ones, winds that blow up or down the valley are much more common than are winds of the same sort outside the valley but only a short distance away. On the shore of almost any large body of water there is a narrow belt where "water" breezes (like sea breezes) often blow on warm afternoons and "land" breezes at night. Such examples of local climates, or local weather, can be found almost everywhere.

QUESTIONS, EXERCISES, AND PROBLEMS

1. From A87 and A88 find out the difference of temperature between summer and winter at latitude 40° N in (*a*) the central United States, (*b*) your home, (*c*) Kansas City, (*d*) the Bermuda Islands, (*e*) Irkutsk. In which place do you find the greatest contrast? The least? Write out an explanation, and illustrate it from other parts of the maps.

2. In order to understand how climate through its effect on vegetation influences the density of population, compare A87 and A88 with A144; and then A107 with A109, using the following methods:

(*a*) In your notebook make a list of regions where sparse population results from low temperature, as in northern Canada; from aridity, as in Arabia; from heavy rainfall combined with tropical heat, as in the Amazon Valley.

(*b*) Make a statement as to the relative sizes of these three kinds of regions with scanty population.

(*c*) What exceptions do you find to the statement that "arid regions contain a sparse population"?

(*d*) How do you explain these exceptions?

(*e*) What exception do you find to the statement that "heavy rainfall combined with tropical heat causes a sparse population"?

(*f*) How do you explain these?

3. (*a*) Using the same maps as in exercise 2 make a list of regions where the population has a density of 100 or more per square mile, dividing the regions into at least four groups on the basis of temperature and rainfall.

(*b*) Write a statement as to the kind of temperature and rainfall most favorable to a dense population.

4. Why do the following conditions prevail? In Ireland the January temperature rarely averages below 40°, and killing frost is rare. In July the average varies only from 59° in the north to 62° in the south. In Kamchatka, in the same latitudes as Ireland, winter temperatures of 40° below zero are common, and some places have a July average as high as 64°.

5. A109 shows the main mode of life in various parts of the world. From a comparison of this map with A87, A88, A100, and A101 make a table having the following headings:

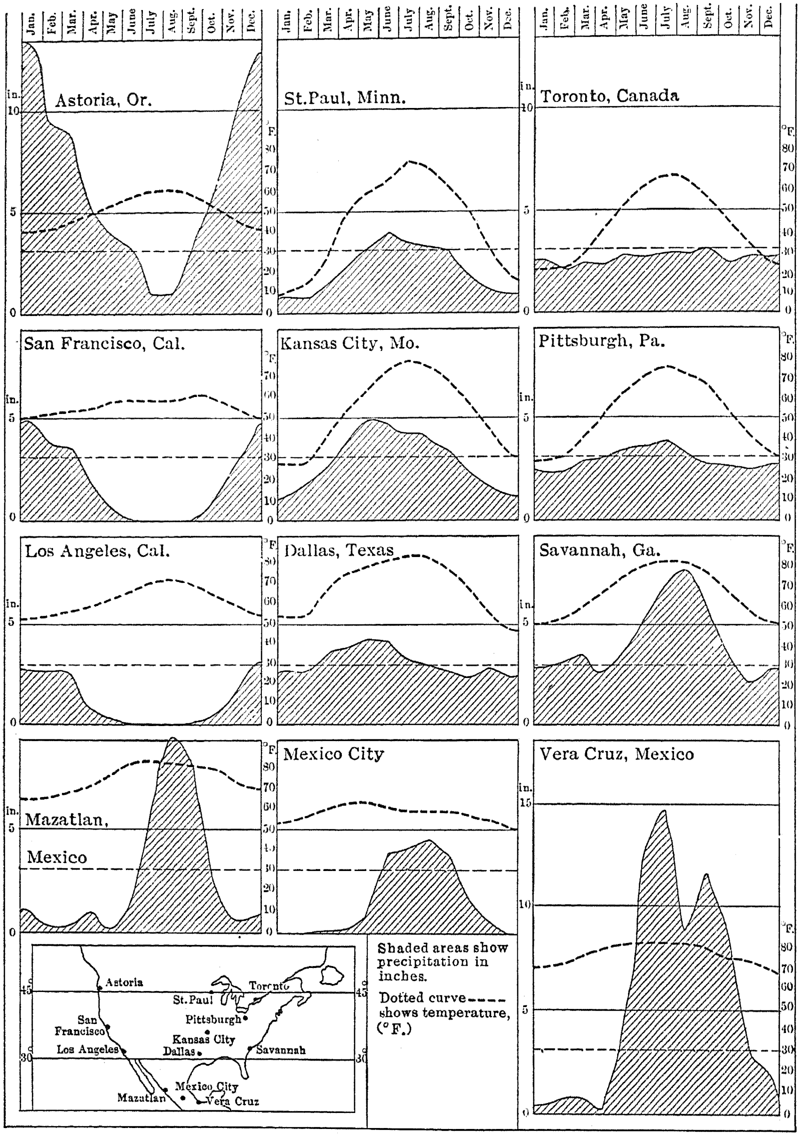
A	B	C	D
Mode of Life	Regions where mode prevails	Temperature conditions: (1) winter, (2) summer	Rainfall conditions: (1) winter, (2) summer

On the basis of this table, what do you infer as to the effect of climate on man's mode of life?

6. From the climatic maps in this book and from relief maps in an atlas, determine the type of equipment needed for a camping trip in or near the following places during the months of May, June, and July: (*a*) Spitzbergen; (*b*) the Ganges Delta; (*c*) Baghdad; (*d*) the center of southern New Zealand; (*e*) Pará; (*f*) Phoenix, Arizona; (*g*) Tomsk; (*h*) Hongkong. Decide for each place the season when travel would be the most pleasant, easy, and interesting, and give your reasons. From A109 and other sources, decide what sort of accommodations for travelers you would find in the smaller centers of population.

7. (*a*) A112 and A113 illustrate the conditions of temperature and rainfall in typical parts of North America and Eurasia, together with North Africa. Select diagrams which furnish typical illustrations of as many as possible of the following climatic types, and state the chief characteristics of their seasonal variations in temperature and precipitation: (1) cyclonic storms; (2) monsoons; (3) continental interiors in the zone of westerlies; (4) subtropical regions; (5) tradewinds; (6) tropical interiors.

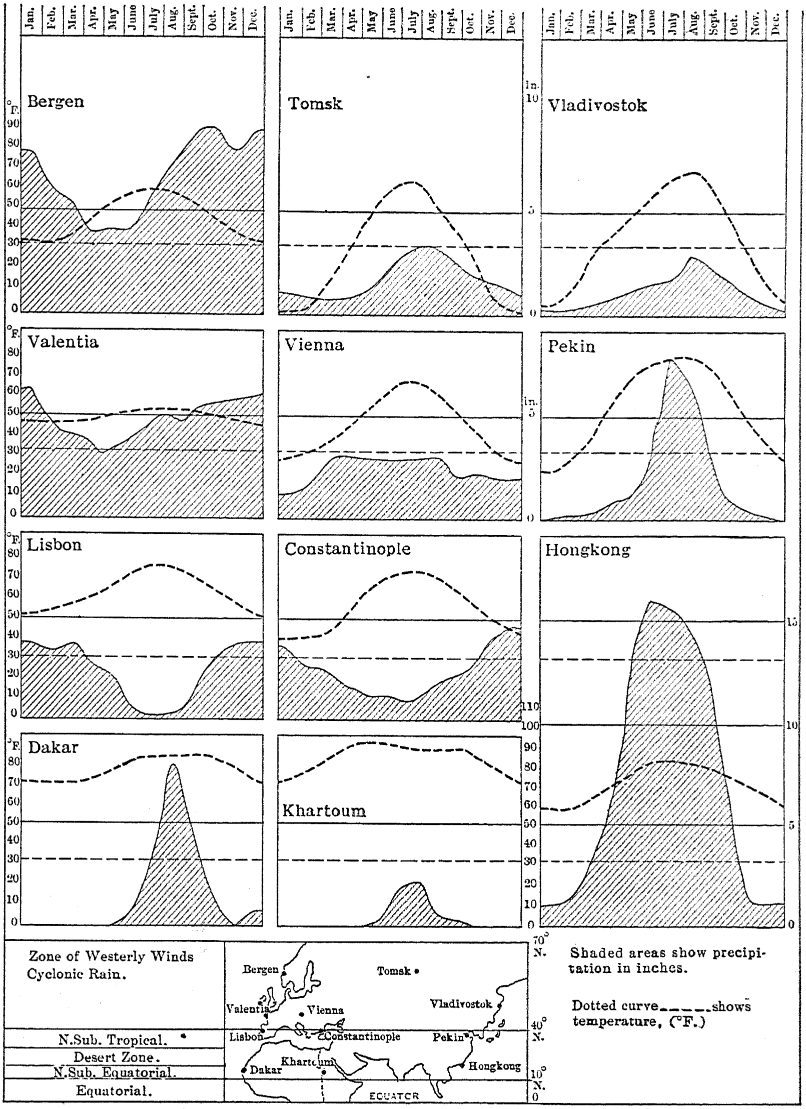
(*b*) For each diagram make a table showing the approximate temperature and rainfall for each month. Explain how the diagrams differ from what would be found in the same latitude on a simplified globe such as is described in Chapter V.



A—Average Monthly Temperature and Rainfall of Typical Places in North America.

(*c*) Among the diagrams of A112 and A113 pick out four in which the effect of relief is evident. Explain.

8. In what parts of A91 and A92 do you find differences between the direction of the wind in summer and in winter? Explain.



A—Average Monthly Temperature and Rainfall of Typical Places in the Old World.

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PART IV

CONTINENTS AND COUNTRIES

CHAPTER VII

COUNTRIES OF THE NEW WORLD

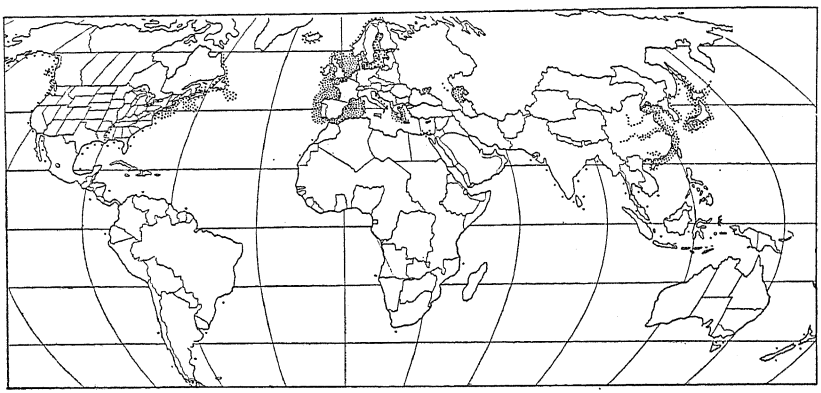
The Continents

Their General Location. In the diagram of human geography on page 4, the second heading under physical factors is "Land Forms." The major land forms are the great uplands known as continents, between which lie the vast hollows of the oceans. This arrangement of continents and oceans is apparently due to the earth's slow loss of heat and consequent contraction. The earth's stiff crust cannot shrink any more readily than can the shell of a nut. The only way to make a nut occupy less space is to break the shell by shoving it inward. In similar fashion during untold millions of years the heavier parts of the earth's crust have slowly fallen inward, forming the oceanic hollows. The higher parts that have not fallen form the lands.

At first glance there seems to be little system in the distribution of the continental uplands and oceanic hollows. Nevertheless, a globe shows that the northern continents form an almost complete band enclosing the Arctic Ocean. From this band three branches extend southward: (1) North and South America; (2) Europe and Africa; and (3) Asia, the Malay Peninsula, and Australia. The Atlantic, Pacific, and Indian Oceans fill the hollows between the branches. Antarctica rises where the southern continents would meet if prolonged southward.

This distribution of the lands as broad triangles surrounding a northern ocean and tapering southward between oceanic hollows is one reason why the northern hemisphere dominates the world. The dominance is due partly to the vast size of the land areas. Such areas suffer extremes of climate and are subject to great variations from one epoch to another. Hence Asia has been a great center where many sorts of animals and presumably man evolved, and from which they have moved outward to other continents in successive waves of migration.

The fact that Asia joins Africa and Europe and is separated from North America and Australia only by narrow bodies of water has helped greatly in spreading Asiatic forms of life all over the world. The fact that four fifths of the lands of the northern hemisphere lie between latitudes 30° and 60° and thus have alternate warm and cold seasons has stimulated the development of civilization. Moreover, the continents are of such shape that they turn vast bodies of warm equatorial water northward in the Gulf Stream and Japanese Current. This warms and improves the winters in northern and central Europe and to a less degree on the North Pacific Coast of North America, but does not particularly influence the summers. One evidence of the favorable nature of such conditions is that all the "Great Powers" are in this zone. On the other hand, four fifths of the area of the three southern continents lies in regions too warm and monotonous to promote human progress.



A—World Distribution of Fisheries.

The Continental Shelf. Although the continents differ greatly in shape, all have certain characteristics in common. One of these is the continental shelf, a submarine platform covered with water less than 600 feet deep. East of the Americas it expands to a width of 100 miles in most places and to as much as 500 where the Falkland Islands stand upon it. Hudson Bay, most of Bering Sea, and large sections of the Arctic Ocean form parts of the shelf. It extends far east of Newfoundland to include the Newfoundland fishing banks. The North and Baltic Seas lie on the continental shelf, as do the Adriatic Sea, Persian Gulf, Yellow Sea, and much of the waters off the southeast coast of Asia. On the other hand, along the west coast of North and South America, around Africa, and off eastern Australia, the shelf is generally narrow, often no more than 5 or 10 miles wide.

If the ocean stood 600 feet lower than now, all these areas would become dry land; the continents would be much larger; their climates would be more continental and hence more extreme, less healthful, and less favorable for crops; and the deserts of the interior would be enlarged. In the past such an increase in the size of the continents has repeatedly been a factor in causing changes of climate which have promoted the evolution of many forms of life, including man.

In human geography the continental shelf is important chiefly because shallow water permits light to penetrate to the bottom of the sea. Hence the sea floor supports many algae, ranging from large seaweeds to one-celled microscopic diatoms. The diatoms swarm on the sea floor and float by the billion as far down as there is sunlight. The algae and diatoms support innumerable microscopic shellfish and crablike crustaceans, which provide food for little fish. The little fish are the prey of bigger fish, and these are caught by man. Practically all the world's great fishing grounds are located on the continental shelf (A116), especially on "banks" where the sea floor rises well toward the surface.

On the outer edge of the continental shelf, the sea floor descends 2,000 to 3,000 feet within a distance of 2 or 3 miles, and then falls off more gently to a depth of about 10,000 feet. This slope, especially the steeper part, is cut into thousands of branching valleys and steep-sided canyons, as if brooks and rivers had flowed down it. An especially deep canyon lies at the end of a shallow trough which can be traced backward nearly 150 miles across the continental shelf until it joins the Hudson Valley. Such valleys occur off the mouths of the Congo, Indus, and many smaller rivers. They have been mapped by a device which measures depths by means of the time required for an echo to come back from the bottom of the sea. There is much dispute whether these valleys were carved by rivers at a time when the land stood much higher than now or in some other way.

Structure of Continents

Although the continents differ in size and shape, they have certain qualities in common. Omitting Antarctica from all consideration in this chapter, the remaining continents tend to be triangular in shape. North America, South America, and Africa taper notably from north to south, as does Greenland, the island most nearly continental in size. Eurasia, which is really a single continent, is also triangular. Australia, alone, is an exception. Again, in all inhabited continents, and apparently in Greenland also, the average height is greater in the south than in the north. In both Eurasia and North America the part north of latitude 50° contains a much larger percentage of lowlands than the part south of 30°.

In South America the Orinoco and Amazon plains form a far large portion of the northern part of the continent than does the Patagonian plain of the part south of latitude 40°. In Africa, extensive lowlands prevail in the north, whereas practically the whole southern quarter forms a high plateau. Even in Australia the only high mountains, the so-called Australian Alps, are located in the southeastern province, Victoria.

Another conspicuous fact is that each continent comprises two main mountain systems with a plain or plateau between them. The Pacific side of the continents tends to be bordered by young, high mountains, while the Atlantic and Arctic sides are bordered by older, more subdued mountains. Again, the general rule is that in high latitudes the seacoasts of all continents are drowned to such an extent that they are fringed with islands in large number, and are deeply indented with fiords, bays, and gulfs of all shapes and sizes.

A Review of Countries

Our primary purpose in this chapter is to refresh our memories as to certain basic but half-forgotten facts learned in the grade school. Although maps are the basis of geography, they are of little use unless studied so carefully that we know where countries, rivers, seas, mountains, and cities are located. Accordingly three chapters are here devoted to a brief study of some of the most important facts about the world's main countries. The chapters should be read with constant reference to the appropriate railroad map at the end of the book and with a relief map from a good atlas at hand.*

English-Speaking North America

Alaska. Although Alaska is not a separate country politically, it is a distinct unit geographically. On a relief map in your atlas or on the wall notice how the northern continuation of the Rocky Mountains separates Alaska from the great northern plain of Canada. West of this, in Alaska itself, mountain ranges on both sides, with the Yukon lowland between them, present the standard features of a continent on a small

* In these chapters each main political division is described separately, but this does not apply to states and provinces. Non-suburban cities of more than 100,000 population in the United States, Canada, and Mexico, and of more than 200,000 elsewhere are mentioned in addition to the main physical features. The main objective is to remind the readers of the general geographic quality of each region and to mention names which a well-informed person ought to know. The more familiar parts of the world receive relatively shorter treatment than those that are less familiar but important. Every student ought to have an atlas and study it intensively. These chapters can most profitably be read with a physical wall map before one.

scale. The Alaska Range on the south, toward the Pacific Ocean, is young and high, rising to the highest level of North America (20,300 feet) in Mt. McKinley, 300 miles west of the Canadian border. On the north, toward the Arctic Ocean, the Endicott Mountains are lower than the Alaskan Range and more mature in topography. Alaska resembles a small continent also in having greater extremes of weather in the interior than on the coast. The summers at Fairbanks on the Tanana branch of the Yukon are warm enough for hay, potatoes, and other crops, although these are often spoiled by early frosts. The inhabitants of Alaska, however, live mainly in the forested south where winds from the ocean keep the winters far warmer than in the interior. Mining among the mountains and fishing along the deeply drowned coast with its many islands offer the best opportunities of making a living. Few people, however, are found in the tundra-covered north, on the long Alaska Peninsula which extends southwestward toward the Aleutian Islands, or on the bleak coast of Bering Sea. The volcanoes of the Alaska Peninsula (Katmai and others) join with earthquakes to furnish evidence that the Pacific Coast is a young, unstable part of the world.

Canada

Canada repeats many features of Alaska on a larger scale. So deeply drowned is the beautiful wooded west coast and so many are its islands that one can sail on a superb inside passage from Tacoma and Seattle to Juneau and Sitka in Alaska. Before the white man arrived the fishing tribes of the Queen Charlotte Islands were among the most advanced American Indians. Today Vancouver Island, with its mild, constantly humid climate, and its little city of Victoria, presents perhaps the most "English" scene in America. High mountains limit the marine climate to a narrow strip and prevent this English quality of British Columbia from penetrating far inland. The wooded young Coast Range, rising steeply from the coast, and the loftier Canadian Rockies, which include the Selkirk and Stikine ranges farther inland, are the typical Pacific kind of young mountains. They interpose an enormous barrier between the coast and the great plain of the interior where the prairie provinces of Alberta, Saskatchewan, and Manitoba are located. They cause the difference in climate between British Columbia and these provinces to be even greater than that between the south coast of Alaska and the interior. East of the Canadian Rockies, a vast lowland 700 miles wide forms a great wheat country in its southern part. Like central Alaska it has a thoroughly continental climate, warm in summer and bitterly cold in winter. The Mackenzie River flows through it, just as does the Yukon through central Alaska.

The eastern edge of the plain is bordered by large lakes—Great Bear, Great Slave, Athabaska, Reindeer, Winnipeg, and Lake of the Woods. Like Lake Superior and the other Great Lakes farther east, they form a chain along the edge of a rough old mass of mountains called the Canadian Shield. This shield extends around Hudson Bay to Labrador, and is continued north in Baffin Land. Although nowhere very high, and in large areas smoothed down almost to a plain, as befits the ancient, well-worn type that faces the Atlantic and Arctic Oceans, these mountains form a rough, rocky region, which is often quite rugged. The icesheet scraped away most of the soil, leaving the bare bones of the country exposed. The large lakes around the border and thousands of small lakes within the shield indicate how much work the icesheet did.

Fortunately for Canada the St. Lawrence River has carved a great Valley across the eastern part of the old mountains, thus separating the Canadian Shield and its Laurentide Mountains (east of Montreal) from the Appalachian System, which begins in southeastern Canada and extends to Alabama. The St. Lawrence Valley both gives an open passage to the sea and provides a fertile, though narrow, lowland. That valley and the lowland triangle between Lakes Ontario, Erie, and Huron provides a home for most of Canada's people in the provinces of Quebec and Ontario. A separate and much smaller group of Canadians lives east of the Appalachian Mountain System in the lowlands of New Brunswick, Nova Scotia, and Prince Edward Island, the Maritime provinces.

The reason why the Canadians live mainly in southwestern British Columbia, the wheat-raising plains of the far interior, the Great Lakes triangle, the St. Lawrence Valley, and the little Maritime provinces is primarily that these regions are warm enough for agriculture. Notice how Canada's large cities cling to the southern edge of the country. To begin with the older East, Quebec and Montreal are located on the St. Lawrence, Ottawa on a branch of that river, Toronto and Hamilton on Lake Erie, Winnipeg in the Great Plains, and Vancouver on the west coast. Only small cities such as Halifax on the east coast and Calgary and Edmonton in the western plains lie more than 60 or 70 miles from the United States. Even Edmonton lies only a little over 300 miles from the border. This concentration of population near the southern border is clearly evident in the Canadian railroads (A566).* Even the road to Churchill on Hudson Bay pierces no more than 700 miles into the

* At the end of this book, before the index, the reader will find 7 railroad maps—6 of the continents and one of the United States. These maps also show international and state boundaries, together with large cities so far as these can be legibly inserted without interfering with the railroads. These maps should be constantly studied while this chapter and the next two are being read.

Northland. Inhabited Canada is merely a narrow band in the southern part of the country. It is broken into four main sections by young mountains on the west and old mountains on the east. In Newfoundland, likewise, practically all the people live on the relatively warm south coast. Although Labrador is famous as a fishing region, its deep fiords and craggy coasts are occupied by only a handful of people.

The United States

An interesting way to fix in mind the main physical features of the United States is to study the railroad map (A565). Beginning in the northwest with the Olympic Peninsula west of Puget Sound, we see that railroads do not hug the west coast, as they do the east coast. To find a through line from north to south we have to go back 50 or even 100 miles from the open ocean to the great valley which is occupied in the north by Puget Sound and continues south as the Willamette Valley of Oregon and then as the great interior valley of California. The Coast Range rises so abruptly from the Pacific Ocean that, although railroads cross it from east to west, no railroad skirts the immediate coast except in the far south. Thus Seattle and Tacoma in Washington, and Portland on the Columbia River in Oregon, have their main connection with San Francisco (Oakland) and Los Angeles through a long winding inland railroad with mountains always in sight on each side. Only in southern California is there a coastal railroad, the one that passes through Los Angeles and gives San Diego its only connection with the north. From the main railroad many little branches start toward the mountains, but do not get far because of steep slopes and scanty population. East of this main north and south railroad the location of the Cascade Range in the north and the Sierra Nevada farther south can be clearly picked out in A565 by the scarcity of railroads. Only at nine places in the entire 1,200 miles from north to south in the United States do railroads cross these ranges, and only at two places in Canada. Such high mountains are a great barrier.

East of the Sierra Nevada and Cascade Ranges the beginnings of a railroad system running north and south at the eastern base of these mountains can be seen. The road is incomplete, however, because aridity, due to the rainshadow of the Sierra, keeps the population so sparse that railroads do not pay. Notice the disconnected bits in Washington and Oregon. Note next the pattern of the railroads in the "Basin and Range" region between the Sierra Nevada and the Rockies. There the main lines run east and west. They often wind most picturesquely because the plateau between the two main ranges is broken by many smaller ranges and by the valleys of rivers. Two lines cross the plateau diagonally to permit

Seattle and Portland and the state of Idaho on the north, and Los Angeles and southern Nevada on the south, to reach Salt Lake City in Utah and connect with lines that radiate from there eastward. Many little branch railways run to mines.

East of the conspicuous railroad centers formed by Salt Lake City and by Spokane in eastern Washington the same kind of irregular, widely spaced railway pattern continues until the east side of the Rockies is reached. It does not pay to build many railways in high mountains. The eastern base of the Rockies is evident in the railway map because it is followed approximately by a railroad which begins in the far south at El Paso (Texas) and goes north through Albuquerque and Santa Fe (New Mexico), Pueblo and Denver (Colorado), and Cheyenne (Wyoming) to Montana. Irrigation from rivers that flow out of the Rockies is a great factor in building up prosperous cities and smaller oases that need this railroad to connect them with one another. Another oasis railroad comes into El Paso from the west. It lies close to the Mexican border and connects the San Diego oasis with the one formed by the Colorado River in the Imperial Valley, and with others in southern Arizona and New Mexico, including the main oasis of the Rio Grande at El Paso.

Farther east a new railway pattern is seen in the "High Plains," as we call them when we recall that Denver lies a full mile above the sea, or the "Dry Plains," as we say when we take note of the fact that they lie in the great rainshadow of the Rockies. Here for an east-west distance of 300 to 500 miles few railroads run north and south in the western parts of Texas, Kansas, Nebraska, and the Dakotas. Nevertheless, at intervals of 50 to 100 miles railroads run east and west. The short grass and sagebrush in this part of the central plains indicate dryness. This explains the absence of cities large enough to warrant the building of railroads except those that connect the East with the West.

At about the 100th meridian west of Greenwich the railroad pattern suddenly changes from widely separated parallel lines to a close network. Here the rainfall is sufficient to support the tall grass of the prairies. Hence agriculture thrives, the population becomes more dense, and the railroads follow suit. Prosperous commercial cities are located along this vegetational border, or a little east of it. A Texas group includes San Antonio, Houston with Galveston, Fort Worth, and Dallas. Farther north Oklahoma claims Tulsa, as well as Oklahoma City. The latter lies on the Arkansas River which comes from Wichita, a similar center of commerce in Kansas. Farther north along the Missouri River we find Kansas City divided between Missouri and Kansas, and Omaha in Nebraska, with Des Moines farther east in Iowa. Winnipeg in Canada on the Red River of the North belongs to this same commercial type.

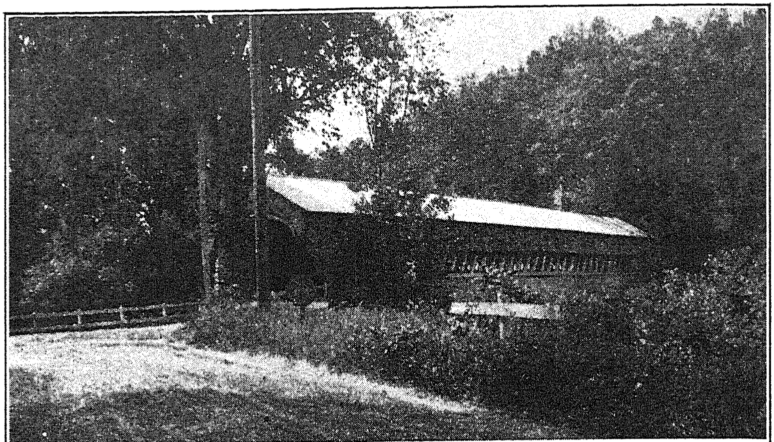
These places are too far west to be prominent in manufacturing but are centers of local trade from which cattle, wheat, and other farm products are shipped eastward. In A565 many of these cities form little stars because the plain permits railroads to come to them from all directions.

Moving east once more we see that in the northern parts of Minnesota, Wisconsin, and Michigan (around Lake Superior and the northern portion of Lake Michigan) the railroads form a more open net than in the prairie belt that we have just examined. Here, in spite of abundant iron ore and copper, the population is sparse because the low glaciated stumps of old mountains have somewhat the same inhospitable quality as those north of Lake Superior in the Canadian Shield. The summers are warmer than there, to be sure, which is a help to crops, but the soil is poor and rocky, and agriculture does not thrive. At Duluth, however, on the western bay of Lake Superior, and farther south at St. Paul and Minneapolis in Minnesota, great cities have grown up, as is evident from the way in which railroads converge from all directions. South of Milwaukee, the chief city of Wisconsin, the railways become part of the extremely dense net which surrounds Chicago, the most wonderful railroad center in the world.

Going on to the south and a little west past Peoria in Illinois we cross into Missouri and find that St. Louis forms another great railway center. Southwest of it, however, an almost bare patch is conspicuous on the map because it has only a few railroads running across it from east to west, and none from north to south. This patch shows how much effect even such low mountains as the Ozarks have upon transportation. Note, too, how dense the railroad net is just east of the Ozarks. Many railroads are there forced to run close together in the valleys of the Mississippi and Arkansas Rivers where Memphis in Tennessee and Little Rock in Arkansas gather the traffic to themselves. Farther south the state of Mississippi has only a fair number of railroads, while those of Louisiana are concentrated along the Mississippi and Red Rivers. New Orleans has been slow in developing as a railroad center because it had no bridge across the Mississippi River until 1935.

From Chicago and St. Louis a dense railway net extends eastward to New Jersey and southern New England. The continental map (A566) shows that from Detroit a similar net runs north of Lake Erie and down the St. Lawrence Valley. North of Grand Rapids and Flint, however, Michigan's railway net (A565) thins out, for farming and lumbering do not support so dense a population as does manufacturing. It is not surprising that there are many railroads south and east of Chicago. Not only is the country level and easily traversed, but also it is highly fertile, and large manufacturing cities are numerous. Indiana supplies Gary,

A



B

C

Courtesy of A. Grenville Price.

A-C—Three Typical Scenes in Rural Northern New England.

A. An old-fashioned, covered bridge.
B. A small farmhouse shaded by a big tree and connected with a huge barn by a kitchen, woodshed, and carriage-house.
C. Small sawmill and filling station.

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South Bend, Fort Wayne, Indianapolis, and Evansville. The Ohio group is unusually large—Toledo, Akron, Cleveland, Columbus, Dayton, and Cincinnati, with which we may well put Louisville in Kentucky. Although Canton and Youngstown are in Ohio, they belong with the coal and iron cities of Pittsburgh and Erie in Pennsylvania and Wheeling in West Virginia. These last two, together with Cincinnati, Louisville, and Evansville, are cities of the Ohio River and its branches.

East of the coal cities the railroads have to cross the Appalachians. Those mountains, as befits the Atlantic side of the continent, are old and well worn, and not very high. Nevertheless, they cause the railway network in A565 to become a little thinner than in the plains. This does not mean that the actual amount of traffic is less, but that more railroads are crowded together into the more favorable valleys. The Hudson and Mohawk Valleys, for example, carry a four-track railroad on one side and a double-track road on the other, but on a small map these appear as single lines. A huge traffic crosses the Appalachians. In exchange for manufactured goods and imports thousands of carloads of coal and food go east to Washington and Baltimore in Maryland, Wilmington in Delaware, Reading and Philadelphia in Pennsylvania, Trenton and Newark in New Jersey, and to New York City itself with its many suburban cities in New Jersey, New York, and Connecticut. Farther north in New York State the Mohawk Valley route across the Appalachian Highland is used for traffic from Buffalo through Rochester, Syracuse, and Utica to the group of cities that includes Albany, Schenectady, and Troy. Within the Appalachians lie the hard coal (anthracite) cities of Scranton and Wilkes-Barre in Pennsylvania. Farther east a heavy traffic for New England railroads is created by Bridgeport, New Haven, Waterbury, and Hartford in Connecticut, and by the Massachusetts cities of Springfield, Worcester, Fall River, New Bedford, Lynn, Lowell, Boston, and its satellite cities such as Cambridge and Somerville, as well as by Providence in Rhode Island.

North of New York City the Catskill Mountains, the Adirondacks, the White Mountains, and then the wild, glaciated northland cause the railroad net quickly to fade out in Vermont, New Hampshire, and Maine. South of Baltimore and Washington it also becomes relatively thin, especially in the Appalachian mountains a few hundred miles back from the coast. East of the mountains such cities as Richmond and Norfolk on the James River in Virginia, Atlanta in Georgia, and Birmingham in Alabama help to keep the railroad net dense. West of the mountains the Tennessee cities of Knoxville and Chattanooga on the Tennessee River and Nashville on the Cumberland have a similar effect. The Appalachian Mountains and the "Tidewater" rivers of Virginia do not favor a dense

railway net. In the Piedmont strip at the eastern base of the Appalachians, where cotton factories are numerous, and in the lower parts of North and South Carolina and the rest of the Atlantic Coastal Plain the traffic does not warrant so many railroads as in the prairies. Finally in Florida railroads are quite numerous on the west side to a point south of Tampa, but aside from the lines from Jacksonville to Miami the east side has not so many. In a large southern section the presence of the Everglades and other swamps has thus far almost prevented the building of railroads. Such swamps add a final element to the conditions of relief, climate, and industry which influence not only the distribution of population, the occupations, and the railroad net of the United States, but a great many other activities in addition.

Mexico

On a relief map of Mexico most of the country appears as a great plateau more than 3,000 feet above sealevel, with almost half above 5,000 feet. In other words, we have here the high southern area which is characteristic of a typical continent. Another outstanding fact is that the plateau rises toward the south. Along half of the American border the altitude is under 3,000 feet, but southward there is a more or less steady rise, until considerable areas, especially just south of Mexico City, lie above 9,000 feet. Both the general high altitude and the rise toward the south are fortunate because they prevent the climate from being hot. Of course, there are steadily hot districts along both coasts, but that is not where most of the people live. The following list of seven cities with more than 100,000 inhabitants illustrates some of the reasons why the Mexicans live on the highlands rather than the lowlands. The Mexicans are no more fond of really hot weather or of drought than we are. The table gives the temperature of the warmest month as well as of July because in much of Mexico the greatest heat comes in May, when the sun first reaches the zenith. Later months are somewhat cooler because the clouds of the rainy season shut out the heat of the sun.

Only Merida is located near the seacoast, and it lies 20 miles from the shore on the peninsula of Yucatan. A similar list for the United States shows that more than a quarter of the large cities are seaports, even though this country has a much shorter coastline than Mexico in proportion to its area. Moreover, the seaports in the United States include a large share of the greatest cities, whereas in Mexico they are little places with less than 100,000 people, such as Vera Cruz and Tampico on the east coast, and Culiacan on the west. This contrast illustrates a characteristic feature of tropical countries, namely, a tendency for the coastal cities to be merely seaports, while other urban and industrial

LOCATION AND CLIMATE OF MEXICAN CITIES

	Altitude in Feet	Population	Mean Temperature ° F. January	Warmest month	July	Precipitation (inches)
I. *Seacoast*						
1. Merida..........	Sealevel	115,000	73	82	82	36
II. *Northern Low Plateau (North of 25° N)*						
2. Monterrey.......	1,600	140,000	58	82	82	23
III. *Southern High Plateau (Lat. 19°–25° N)*						
3. San Luis Potosí..	6,200	100,000	55	71	68	14
4. León...........	6,000	105,000	57	74	69	26
5. Guadalajara......	5,200	190,000	60	74	69	41
6. Mexico City.....	7,500	1,100,000	54	65	62	23
7. Puebla..........	7,100	130,000	54	68	63	36

activities seek the highlands if such a course is possible. All the Mexican coastal cities have hot summers averaging 80° or more for several months, and the winters are as warm as the summers of the northern United States.

The table of Mexican cities also shows that Monterrey in the northeast is the only other large city beside Merida which lies at an altitude below 5,000 feet. It is as hot as Merida in summer, but has a pleasant springlike temperature in winter. In most of northern Mexico, especially the part west and northwest of Monterrey, the rainfall is light, as is common in the interior and on the west side of continents in latitudes 25° to 30°. Because of this the vegetation is grassy or consists of scrubby trees and bushes, and the western part is a desert. Agriculture is difficult without irrigation, and cattle raising is common.

The most remarkable part of our list of Mexican cities is the third section with its five cities on the high southern part of Mexico between latitudes 19° and 25° N. They lie on a high plateau which is about like Minnesota, Wisconsin, and Michigan in size (200,000 square miles) and population (nearly 11,000,000), but very different in relief. The density of the population on the Mexican plateau is especially remarkable in view of the many high mountains such as the volcano Popocatapetl, which break its surface, and the still more numerous precipitous valleys that have gnawed headward deep into its sides. The explanation lies partly in good volcanic or alluvial soil, but still more in the comfortable climate with its pleasant temperature and generally good rainfall. Among the eleven cities of the high southern plateau even the warmest has no month

with a temperature more than about one degree higher than New York in July. The coolest, on the other hand, is never hotter than the July temperature of Eastport at the eastern end of the Maine coast. The winter temperature is like that of the Atlantic Coast from Charleston, S. C., as far south as Tampa, or the Pacific Coast from San Francisco southward. A visit to the high part of Mexico is pleasant at any time of the year, but especially in summer when the rains make the land green. The winter is dry and dusty. The Mexicans themselves consider that Guadalajara and especially Jalapa have unusually pleasant climates. A Mexican proverb says that the Jalapa women (Jalapenas) are the charmers (halagüeñas), the reason being that they have good health and rosy cheeks.

The railway map (A566) illustrates the ruggedness of Mexico, as well as the relatively low productivity and the low volume of trade. Four lines enter the country from the United States, but no line keeps close to the hot humid coast. The eastern line heads for Tampico on the east coast because Americans were formerly much interested in the oil there. The other three all head for Mexico City and the neighboring cities such as Guadalajara and Puebla. Many of their little branches have been built by Americans or other foreigners to reach some of the many silver and other mines for which Mexico, especially the northern plateau, is famous. Only around Mexico City, however, is there even a hint of a genuine railway net such as covers the whole of the states bordering Lakes Michigan and Superior. The scarcity of railroads in the south of Mexico, in Lower California, and in a vast area northwest of the main southern plateau is conspicuous. Extreme dryness in the north, the steepness of the mountain slopes in the center, and the abundance of dense tropical forests in the south and in the lowlands are reasons for this. The little star of railroads around Merida at the northern end of Yucatan is interesting. That peninsula has a lowland topography not greatly different from that of Minnesota except for innumerable caves and hollows due to the dissolving of the limestone by running water. At its northern end there is both a wet season and a dry season, so that agriculture is possible, and the henequen plant grows well. Therefore railroads have been built to bring this fiber to Merida. Farther south the dry season becomes so short and the forest so huge that agriculture is very difficult and there are practically no inhabitants aside from a few wandering savages. Similar conditions are found in British Honduras.

Taken as a whole Mexico furnishes an admirable example of four kinds of handicaps which beset many countries in low latitudes: (1) the dry, hot deserts of the northwest including Lower California; (2) the steep slopes both on the escarpments up which one must go to reach the plateau, and on the many mountains that rise above the plateau; (3) the

heat and humidity of the lowlands; and (4) the extremely rank growth of vegetation in the forested areas, especially on the eastern lowlands and the eastern slopes where the trade winds bring moisture from the sea at seasons which would otherwise be dry. Such handicaps are so widespread in low latitudes that it is worth while to get a clear idea of them here where we first meet them. The contrast which they present to the high plateau with its moderate temperatures and rainfall, its easy agriculture, and its dense population is striking.

Central America

The little countries of Central America (A566) repeat the features of Mexico on a small scale. They are characterized by three main features: (1) The first is a northern, or eastern coastal plain. Everywhere this gets abundant rain in summer after the noonday sun has reached the zenith and then moves on toward the north. At other seasons most of the coastal plain gets some rain because the tradewinds have to rise over mountains or plateaus on its west side. Thus the eastern lowlands and the eastern or northern slopes of the mountains behind them usually get rain at practically all seasons, and are covered with a dense tropical rainforest. Agriculture is difficult, although there is considerable good banana land.

(2) The second part of these little Latin American Republics is a central elevated tract. In *Guatemala,* the most northern republic, this rises to a height of more than a mile and forms a plateau with mountains on both sides. Volcanoes and marvelous lakes dammed by lava make the scenery unusually inspiring. Here, even more than in Mexico, the population is largely Indian. In Mexico, mestizos, or people of mixed Indian and Spanish descent, predominate, but in Guatemala the majority are pure Indians. Living as they do on a high cool plateau, they are wise to wear thick woolen blankets. These are hot by day, but when the sun disappears and cool winds blow across the plateau, it is very comforting to stick one's head through a hole in a blanket and let the blanket hang down around one's legs.

How important the high part of the country is may be judged from the fact that five of the seven capitals of Central America lie at high altitudes, as appears in the following table:

Country	*Capital*	*Altitude of Capital*	*Population of Capital*	*Population of Country*	*People per Square Mile*
Mexico	Mexico City	7,400	1,100,000	19,000,000	25
Guatemala	Guatemala City	4,900	134,000	2,400,000	55
Honduras	Tegucigalpa	3,200	47,000	1,000,000	22
Salvador	San Salvador	2,100	100,000	1,600,000	121
Nicaragua	Managua	150	40,000	850,000	17
Costa Rica	San José	3,700	70,000	600,000	32
Panama	Panama City	Sealevel	74,000	530,000	16

(3) The third section of the Central American republics is the western or southern slope of the central mountains and plateaus, together with a small coastal plain along the Pacific Ocean. Being protected from the tradewinds by the high land to the north and east, this section gets little rain during our winter when the sun is far to the south. In fact some parts are too dry for agriculture. Nevertheless, on the whole this section is much more habitable than the wet eastern or northern slope, although not so good as the plateau. How great the difference is may be judged from the density of population in Salvador (121) compared with Honduras (22). The relief map shows that Salvador lies wholly on the drier south side of the mountains, while Honduras lies mainly on the wet north side, with access to the Pacific Ocean only at the beautiful island-studded Gulf of Fonseca.

Nicaragua is unfortunate because the plateau breaks down in its territory and is replaced by two great lakes, Nicaragua and Managua. The lakes interest Americans because they would form a major part of an interoceanic canal, if a second canal should be built to supplement the one at Panama. They are not much help to Nicaragua. Most of that country consists of a densely forested low plain extending back 50 miles or more from the Atlantic Ocean, and of very rugged, wet, and heavily forested mountains which slope toward the tradewinds. The mountains are a great place for revolutionary bands of the kind which American marines formerly tried to suppress, but they are of little use for peaceful people who want to make a living. Because of such conditions, the capital, Managua, is located only a little way back from the sea and only a little above sealevel. This helps to make the government inefficient, for the climate is enervating and disease is rife. As a result of all these factors Nicaragua has only 17 inhabitants for each square mile.

Costa Rica, like Guatemala, is fortunate in having a relatively large plateau and a greater length of seacoast on the drier Pacific side than on the wet Atlantic side. This has helped it to be more fully a white man's land than any other Latin American republic until Chile, Argentina, and Uruguay are reached in the far south. Negroes live on the coast, as they do on most coasts of tropical America, but they have not yet penetrated far into the highlands.

At Panama the mountains break down until they are only a few hundred feet high at the canal. This fact as well as the narrowness of the isthmus helps to account for the location of the canal in that country. In spite of the slight elevation of the hills the climate on the two sides of Panama is quite different. Colón at the northern (Atlantic) end of the canal gets 127 inches of rain per year; Panama City at the other end, away from the tradewinds, gets 69. Elsewhere in Panama the mountains

are higher than at the canal and the contrast between the two sides is greater. The densely forested north side is the home of some of the least-known Indians. The south side, however, contains much grassy land where people of Spanish or mixed mestizo descent raise cattle.

A566 shows that neither Nicaragua nor Honduras has yet built a railroad from one ocean to the other. Guatemala, Costa Rica, and Panama each have only one, while Salvador is connected with the Atlantic by the Guatemala Road.

The West Indies

The West Indies form part of a series of mountains which run east and west, instead of north and south as do most of the mountains of America. They are only the tops of the mountains, but it is easy to see that a Cuban ridge and a Jamaican ridge unite in Santo Domingo and go on east through Puerto Rico. Then the united ridge bends south in the Lesser Antilles to the British island of Trinidad. Where the two ridges unite in the Dominican Republic the mountains rise highest, reaching well over 10,000 feet. Only four islands need concern us here: Cuba, which is an independent republic; Jamaica, a British colony; Hispaniola, which contains the so-called Black Republic of Haiti on the west and the Dominican Republic on the east; and Puerto Rico, which belongs to the United States. All these are mountainous, but Cuba has a large proportion of lowland. This is one reason why it produces so much sugar. Inasmuch as northern slopes get rain from the tradewinds during our winter, the north side of each island and of each mountain range has more rain and heavier forests than the south side. During our summer all parts of the islands get rain of the kind which normally falls in tropical countries after the sun reaches its highest level. On the south side the mountains create so great a rain-shadow that in winter for many months there may be no rain at all. This, together with the warmth of the winter, causes all the islands to have scrubby forests and much grass on their south side.

The density of the population in the West Indian republics is surprisingly great. Here are the figures.

	Area	*Population*	*Population per square mile*
Cuba	44,200	4,500,000	102
Jamaica	4,500	1,150,000	256
Haiti	11,100	2,700,000	244
Dominican Republic	19,300	1,500,000	78
Puerto Rico	3,400	1,800,000	530

Inasmuch as the West Indies depend almost wholly on agriculture, such figures indicate that the islands are among the world's most productive

regions. In Central America only Salvador has a density of population equal to that of Cuba and the Dominican Republic, but such density is a small matter compared with that of Haiti, Jamaica, and especially Puerto Rico. Only in a few other places such as Java and Hawaii does tropical agriculture reach any such high level of productivity as in Puerto Rico.

The secret of this lies partly in the rainfall. In large parts of the island abundant, but not excessive, rain falls during about eight months, and there is a drier, but not really dry, season in our winter. On the south side the dry season is longer and more severe, but the difficulties arising from this are considerably diminished by irrigation. Another factor is soil of unusually good quality derived from volcanic rocks and limestone. A third factor is greater care in cultivation than is given in most parts of the tropics. The fact that sugar and other plantation products grow especially well has been an element in promoting good cultivation.

Still another factor is that compared with tropical people in general the Puerto Ricans are good workers. A location far out in the ocean helps to give Puerto Ricans vigor because it permits the tradewinds to blow freely. A location close to the border of the tropics brings the benefit of at least a "cooler" season, even though this season is as warm as the summer of the northern United States. Where people work well the population tends to become dense. In studying tropical countries, it must be remembered that only in a few small and especially favored areas is it possible to have any such profusion of crops and any such density of population as in the West Indies, and above all in Puerto Rico. Unfortunately, however, the density of the population is so extreme that great poverty prevails.

Even where the population is dense the tropical type of development does not especially foster large cities. San Juan, the capital of Puerto Rico, has only 137,000 people; Port-au-Prince in Haiti is considerably smaller. Santo Domingo in the Dominican Republic and Kingston in Jamaica are only half the size of San Juan. Havana in Cuba, however, is an exception. Aside from Mexico City it is the only city of more than half a million people in all of Latin America until Rio de Janeiro is reached in Brazil. Its size is due partly to the great sugar industry of Cuba, partly to a location on a much-traveled water route from the northeastern United States and Europe to the Gulf States and Mexico, and partly to fame as a tourist center.

South America

South America is a delight to the geographer because it furnishes so clear an illustration of a "typical continent." (1) One of the typical features is a lofty western cordillera, or series of young mountain ranges and plateaus, rising steeply from the Pacific Ocean. The youth of this cor-

dillera of the Andes is evident from the abundance of volcanoes and earthquakes and from old strands of the sea hundreds or thousands of feet above the present coast. (2) A second feature is a great central plain. This begins in the Llanos, or level grassland spreading widely on both sides of the Orinoco River. It is continued in the Selvas, or great forested plain of the Amazon, and in the scrubby Gran Chaco of the upper Paraguay River. It then passes into the Pampa, or prairie-like grassland of Argentina, and finally into the short grass of Patagonia. (3) A third typical feature is a double eastern highland. Part of this between the Orinoco and Amazon rivers forms the sparsely populated and little-known highlands of southern Venezuela and Guiana. The main part occupies all of Brazil south of latitude 5° S and east of the Tapajoz and Paraguay rivers. (4) In addition to these three large features a smaller typical feature is the depression of the southern end of the continent. Hence the coast south of latitude 40° is deeply indented, especially on the west side where there are hundreds of islands in Chile.

Five Andean Countries. Venezuela, Colombia, Ecuador, Peru, and Bolivia form a group of tropical countries which lie astride the Andes. All alike have their greatest population and most numerous cities at high elevations. The elevation increases as one goes from north to south, as appears in the following figures:

Country	*City*	*Population*	*Altitude, feet*
Venezuela	Caracas	141,000	3,000
Colombia	Bogotá	350,000	8,700
Ecuador	Quito	115,000	9,300
Peru	Cuzco	40,000	11,100
Bolivia	La Paz	150,000	11,800

All the cities except Cuzco in Peru are the present capitals of their respective countries. Cuzco was the capital of ancient Peru in the days of the Incas, and it is famous for its great ruins where huge stones of many shapes and sizes are carved so accurately that even the little corners fit together so closely that a knife cannot be stuck between them. Ruins of a high ancient civilization abound in all these countries, especially in the higher parts of Ecuador, Peru, and Bolivia.

The importance of the high plateau is evident in the railroad map (A567). One or two hundred miles back from the west coast and roughly parallel to it many little scraps of railroad are seen. If they were joined together, as they probably will be some day, they would form a route connecting the five Andean countries with one another and thus with Argentina and Chile. Notice also how scanty are any railroads running east from this line until Argentina is reached. Many little railroads start inland from the west coast but end abruptly at the foot of the Andes.

The absence of railroads running down the east side of the Andes brings out another similarity in all five of the tropical Andean countries. Each of them has a large eastern lowland (southern in Venezuela) which is almost uninhabited and of little use. The eastern slope of the mountains in every case is covered with dense forest because plenty of rain is brought by the tradewinds. A few plantations have been started here, but they rarely pay because of the expense of carrying the products across the mountains or down the rivers to market. For the most part the slopes are left to a few wild Indians. Farther east the great lowland forms a grassy plain or savanna in the Llanos of Venezuela. In the Amazon section of Brazil, however, it is covered with "selvas," the finest kind of tropical rainforest full of huge trees where parasitic lianas hang down like green ropes. In southern Brazil and Bolivia the rainforest gradually gives way to a scrubby, dry forest where trees that suggest a peach or apple orchard are scattered about among tall grass.

Going back now to the west coast, we find that it is the most diverse part of the Andean countries. It varies from huge rainforest and the densest tropical jungle to utter desert where one cannot see a single plant for miles at a time. Along the Caribbean Coast and on the Pacific Coast as far as Guayaquil, the port of Ecuador, forests prevail, often scrubby on the north, but generally dense on the west. In Ecuador, just south of Guayaquil, there is a sudden transition to the driest kind of desert. This continues as a narrow strip along the western base of the Andes for about 2,000 miles to central Chile. The desert is due partly to the fact that tradewinds from the east are cut off by the high Andes, and partly to the cold Humboldt Current that flows northward along this whole coast. When winds from its cool water reach land that is heated by the high sun of low latitudes, they are warmed so much that they cannot give up moisture.

Curiously enough this desert was the seat of a high civilization in the past, and is now the location of Lima, the capital of Peru. If we omit Santiago, the capital of Chile, which lies 60 miles back from the coast, Lima and its port of Callao 8 miles away form the largest city on the whole west coast of America south of Los Angeles. There are many other small cities along this coast, and some large sugar plantations. Often the cities are in pairs like Callao and Lima—a little, barren seaport connected by rail with a green oasis a few miles inland. Such cities and plantations exist because the snowy Andes provide irrigation, just as does the Sierra Nevada in California. The Humboldt Current makes this coast so cool that men wear woolen suits at all seasons. The people of Lima sometimes go inland to enjoy warmer weather. Of course there is little difference between summer and winter.

The Guianas. The Guianas—British (Demerara), Dutch (Surinam),

and French (Cayenne)—receive the full force of the tradewinds in our winter and are under the influence of the vertical sun and its aftermath of

Keystone View Co.

A—Waterside Market at Guayaquil, Ecuador.

Most of the boats are "dugouts," each one hollowed by fire and axe from a tree trunk.

rain the rest of the year. Hence the coasts and the northern and eastern slopes of the high plateau which rises not far inland get 90 inches or more of rain per year. They have no really dry season, only one that is drier

than the rest of the year. The constant heavy rain has much to do with the fact that, although these three regions are the only parts of South America owned by Europe, they have only 520,000 inhabitants in an area the size of the British Isles, Switzerland, Belgium, the Netherlands, and Denmark, which together have over 70,000,000. The few inhabitants are largely concentrated within a few miles of the coast. The rest of the country consists of dense forests, which become scrubby in the interior where the mountains shut out the tradewinds and create a rainshadow. There a long dry season alternating with an exceedingly wet season presents another kind of handicap.

Brazil. A similar concentration of population near the seacoast in Brazil (A567) illustrates the fact that South America, like every other continent, is much more humid on the east than on the west. In latitudes where the coast of Peru has an intensely dry desert, the narrow Brazilian coastal plain and the slope to the plateau behind it are drenched with rain and shrouded in forests. The tradewinds supplement the solsticial rains —that is, the rains which occur when the sun reaches the solstice and is vertically overhead at noon. This gives abundant rain most of the year and light rain for two or three months. The effect of this fortunate combination is evident in the concentration of population on the east coast of Brazil, as appears in A567. Each dot there stands for 100,000 people. The benefit of this kind of rainfall is also evident in the following list of cities, arranged according to their location from north to south, beginning at the mouth of the Amazon. Unless there is some comment to the contrary the cities are on the seacoast; those which lie inland are starred.

City	*Population*	*Comments*
Belem	320,000	Only seaport for Amazon drainage area almost as large as U. S. A.
Manaus*	90,000	River port 800 miles up Amazon, slowly declining in importance
São Luiz	70,000	
Fortaleza (Ceara)	153,000	
João Pessão	105,000	
Recife	480,000	
Maceio	129,000	
Bahia	364,000	
Bello Horizonte*	170,000	Altitude 2800, 200 miles from coast
Nictheroy	125,000	Suburb of Rio de Janeiro
Rio de Janeiro	1,700,000	Second city in size in southern hemisphere
São Paulo*	1,160,000	Altitude 2,700, about 40 miles from coast, on plateau
Santos	105,000	World's greatest coffee port, almost a suburb of São Paulo
Curitiba*	117,000	Altitude 3,000 feet, 70 miles from sea, center for Paraguay tea
Porto Alegre	330,000	

Although Brazil is much larger than the United States and has a shorter coastline, all but four of its fifteen largest cities are on the seacoast. Two of the others are within 100 miles of the coast, and one is 200 miles away. Only Manaus is far in the interior, but ocean steamers can reach it on the mighty Amazon. Not only is it one of the smallest cities in our list, but it is also declining in population. Compare this with the United States where Chicago, Detroit, Cleveland, St. Louis, and Milwaukee are only a few of the great interior cities. Note, too, that aside from Manaus the other three interior cities of Brazil are located well to the south on the plateau at an altitude of nearly 3,000 feet.

Another impressive evidence of the way in which the 40,000,000 or more people of Brazil are concentrated near the sea is seen in the railroad map (A567). Only in a small southern section, with Rio de Janeiro and São Paulo as the centers, is there any approach to a genuine railway net. In most places there are no railways whatever. On the railroad map one can easily mark out an elliptical area larger than the United States without including a single mile of either railroad or motor road. The reason for all this is primarily climate. In the first place, except in relatively narrow strips the climate of the main Amazon Basin is so constantly rainy that agriculture is very difficult. Farther from the equator a hot enervating season of heavy rain alternates with a distressingly dry season which is also hot. This combination also makes great difficulty for agriculture. In the second place, the soil is generally very poor because tropical heat and moisture cause it to decay rapidly and the soluble plant foods are washed away by the rain. Because of this many of the higher areas between the rivers are covered mainly with grass and will not yield good crops. In broad areas near the rivers, on the other hand, the soil is often so waterlogged as to be useless. Accordingly the good parts of Brazil are largely limited to two regions: (1) the coast, where abundant rain during most of the year is interrupted by a short dry season, and where the soil is quite good; and (2) the southern part of the plateau south and west of Rio de Janeiro and São Paulo. There the winter temperature is low enough so that the dry season does not prevent the growth of such valuable plants as the orange tree, coffee bush, and yerba maté with its holly-like leaves from which Paraguay tea is made.

Paraguay. The little country of Paraguay, tucked away between southern Brazil and northern Argentina, is far enough south so that the disadvantages of the wet and dry climate which prevails in the interior of Brazil between 10° and 20° from the equator are somewhat mitigated. It also has good soil in many places near the Paraguay, Paraná, and other rivers. Nevertheless, in an area the size of pre-war Germany, where there are 68,000,000 people, it has only about 900,000. Only one railroad pene-

trates this flat country. It comes from the south, although it might come from any direction so far as the relief of the land is concerned. The importance of the Paraguay River as a route of travel is indicated by several tiny railroads which run out from the river north of Asunción, the capital, where the main line ends.

Uruguay. Uruguay is more fortunate than Paraguay because it lies farther from the equator and near the sea. Its rolling plains and gentle hills present a most desirable type of topography. Nevertheless, there, too, although the rain is quite well distributed through the year, there is so much drought that large areas are covered with short grass rather than trees and are not reliable for agriculture. So long as the population is not too dense this does little harm, for the people can devote themselves to cattle raising. The rolling hills are excellent for this, and the two million people of Uruguay raise an enormous number of cattle. In the south, where there is more rain, Uruguay is a pleasant agricultural country. Its capital, Montevideo, is a city of which any people might well be proud. The railroad net, however, is only about as dense as in northern Mexico, or the drier part of Texas. In fact central Texas and Uruguay are alike in many ways.

Argentina. If we had no information about Argentina except the railroad map (A567), we could at once tell a good deal about it. The latitude, 22° to 52° S, and the location in respect to the sea, tell us that the northern interior must be hot and have rain only in summer, except among the mountains. The central latitudes, however, on the east side at least, must have a fairly good rainfall well distributed through the year. The density of the railway net in this section indicates not merely that there are a good many people, but also that they are active enough and prosperous enough to do a great deal of business. The straightness of the railroads, the way in which they radiate from Buenos Aires, and the parallelism of those that run farthest west indicate that this central region is a plain. The fact that most of the railroads end only 300 or 400 miles west of Buenos Aires suggests that the plain becomes drier as one goes westward. The way in which the Argentine railway net resembles that of the western United States and Canada on a small scale is most interesting.

The scarcity of railroads south of latitude 40° suggests that for some reason that part of the country is sparsely populated. The latitude, however, is not high enough to prevent agriculture, except in the far south. Some other handicap must be at work. Can it be the relief? The fact that the few railroads south of the main railway net as well as west of it run nearly straight suggests that mountains are not an obstacle until one is some distance away from the coast. We know from the relief map that such is the case. The further fact that all except one of the railroads

that head westward come to an end without joining the railroads in Chile suggests the presence of some great barrier. The relief map shows that this is the Andes Mountains. The one railroad which crosses the continent winds high over the Andes to connect Buenos Aires, the Argentine capital, with the chief cities of Chile, namely, the port of Valparaiso and the capital, Santiago. Note the way in which a north-south railroad is beginning to be built on the east side of the Andes just as on the east side of the Sierra Nevada and the Rockies in the United States. It starts out in both directions from the fruit-raising city of Mendoza where the trans-Andean line leaves the plain and enters the mountains.

The presence of the lofty Andes explains why there are so few people and railroads south of latitude 40° in Argentina. The winds in this latitude, especially in the southern hemisphere, blow mainly from the west. Hence they give up much moisture when they rise over the Andes in southern Chile, but have little left when they descend on the east side. So, although there is plenty of level land and a favorable temperature in much of Patagonia, there is not rain enough to support reliable agriculture. Naturally sheep raising is the main occupation.

These various facts mean, of course, that most of the cities of Argentina must be located where the relief, the harbors, the soil, and the climate have made it worth while to build the densest railway net. With such a net we should expect inland cities, and we are not disappointed. From La Plata, the outlying port of Buenos Aires, one can go by small steamer or rail to Buenos Aires itself and its suburb Avellaneda where more than two and a half million people are living. Then by rail or water one can go 120 miles inland up the Paraná River to the great grain and cattle city of Rosario with over half a million people. Leaving the river one goes by rail northward to the commercial center of Santa Fé, then west to a similar center at Córdoba, and finally far north to Tucumán, the center of an irrigated sugar district at the eastern base of the Andes. If one goes westward from Buenos Aires, one travels 600 miles over an extremely straight railroad before reaching another irrigated region where Mendoza, with somewhat less than 100,000 people, is a famous fruit center. The only other direction in which one can find a large city is 360 miles south and a little west of Buenos Aires where Bahia Blanca is another seaport. Thus three seaports, a river port, and four smaller inland cities make up Argentina's total. These contain a third of the country's entire population. Such a high proportion of city dwellers, in contrast to only one eighth in Brazil, indicates prosperity.

Chile. The way in which the railroads of Chile mimic those of the west coast of the United States is impressive. From the utterly desert nitrate beds of Atacama in the far north to the Gulf of Corcovado, where

Chile's fringe of islands begins in the far south, the main railroad runs most of the way at a distance of 50 miles more or less from the coast. The reason is that in the north the nitrate beds, the few oases where there is irrigation, and almost all other sources of livelihood, such as mines of copper, silver, and borax, are located on terraces high above the sea. Farther south, where the desert gives way to a climate like that of California, a valley between the Andes and the Coast Range is somewhat like the great interior valley of California. It is a place where irrigation is feasible on a large scale. Here the vegetation naturally consists of grass and hard-leaved trees such as grow in California and Greece, and the crops include wheat, oranges, and grapes. Still farther south where the islands become numerous, the climate becomes too cool and wet for crops. Hence coniferous forests, composed largely of the umbrella pine or auracaria, densely clothe the hillsides. The population is very scanty. Between deserts on the north, the sea on the west, the steep slopes of the snowy Andes on the east, and cool coniferous forests and rain-drenched islands on the south, Chile has thus far found room for less than five million people. Its only large cities, Santiago and Valparaiso, lie close to the middle of the country and contain nearly one fifth of the population.

From the population map (A144), the railroad map (A567), and a relief map in an atlas, try to sum up the reasons why South America is so different from North America. The chief difference is that South America has its main lowlands just where the equatorial climate is least favorable to human progress. Another significant difference is that the Andes rise so high that their ruggedness and their effect in shutting out the west winds make the continent almost uninhabitable south of latitude 40° in the very part which otherwise might be most prosperous. A third difference is that in South America the population clings to the coasts, or to the plateaus, almost everywhere except in Argentina. The railroad map makes one wonder how long it will be before either a railroad or a motor road crosses the great blank equatorial tract, much larger than the United States.

Australia and New Zealand

Australia is the simplest and least habitable of the continents. One of its main physical features, just as in both Americas, is a mountain range extending the whole length of the Pacific Coast and rising toward the south. This range culminates in the Australian Alps where Mt. Kosciusko rises 7,300 feet. In many parts, however, the range degenerates into a mere escarpment, or upward slope with a plateau some 2,000 or 3,000 feet high at the top. Streams that flow down the escarpment have cut deeply into the plateau. Hence in many places the well populated, but very

narrow coastal plain is separated from the rolling wheat lands of the plateau by an almost uninhabited rugged region 50 to 150 miles wide. In A571 one can see this as a long open space between a coastal railroad and one farther inland between Brisbane and Sydney. Sometimes there is no coastal plain at all. Hence the railroad nearest the east coast is interrupted between the two great cities of Sydney and Melbourne. The train from Sydney has to wind upward through the no-man's land of the escarpment in order to run south on the plateau.

On the west toward the Indian Ocean, Australia is bordered by a plateau which is lower and rises less abruptly than the plateau on the east. Near the center of the continent another plateau rises in places to a height of about 4,000 feet. There the northbound transcontinental railroad comes to an end at a place almost too small to be called a village. Most of the interior, however, consists of a vast plain corresponding to the greater interior plains of North and South America.

Both the topography and the latitude of Australia tend to make the country uninhabitable. The mountains along the east and west coasts keep out ocean winds which would bring rain. The latitude is such that most of the continent lies in the desert belt between 20° and 30° from the equator. The northern part lies in tropical latitudes where there is generally too much rain when the sun rides high, and a long, severe dry season the rest of the year. Hence practically all the Australians live in three places: (1) close to the east and south coasts from the sugar-raising districts in latitude 15° to Adelaide where a deep bay juts inland on the south coast; (2) on the eastern plateau in the parts where a genuine railway net has begun to develop; and (3) in the southwest corner near Perth. Between these two inhabited sections the desert comes to the south coast in the great Australian Bight, and the train travels all day among sand and gray-leaved desert bushes. Nine tenths of Australia is practically uninhabited either because of hot deserts or excessive contrasts between the wet and dry seasons in low latitudes.

The location of Australian cities is as simple as the general physical structure of the continent. All those of any large size are on the coast; each is the capital of a state; and each contains a surprisingly large proportion of the people in its province. Brisbane, the most northern large city, has a third of the one million people in Queensland. The northeastern coast of that state is the only tropical region where white men from northern Europe regularly engage in hard manual labor such as cutting sugar cane. Sydney, the next city to the south, contains half the people of New South Wales and is famous for the beauty of its drowned harbor. At the southeast corner of the continent Melbourne almost rivals Sydney as a city of more than a million people. It contains 55 per cent of

the population of Victoria. A similar relationship between city and state prevails as to Adelaide and South Australia, but the number of people is only one third as great as in Victoria. Perth, with more than 200,000 people, has nearly half the population of Western Australia. There are two other Australian provinces. One is Tasmania, a hilly little island with only eight or nine people per square mile but with a good ring of railroads. The other is the great, hot Northern Territory where there are only one white person and four natives for every 125 square miles.

New Zealand, with its two main islands, is often spoken of as if it were closely connected with Australia. As a matter of fact, the distance from Sydney to Auckland is nearly 1,400 miles. Although New Zealand is about seven or eight times as densely populated as Australia, it has only about fifteen people per square mile. So far as climate is concerned it might support ten times as many. The country is new, however, which is one reason for scanty population. Then, too, South Island and the southwestern part of North Island are so extremely mountainous and rugged that they can never support many people. That is why railroads are so scarce in A571. The mountains are of the young volcanic type which is typical of the borders of the Pacific Ocean. The concentration of population in a few cities is not so extreme in New Zealand as in Australia. Auckland, on a narrow neck of North Island, is the only city of more than 200,000 population. Nevertheless, about half the New Zealanders live in cities of more than 20,000 population. The high percentage of city dwellers in both New Zealand and Australia is evidence of the prosperity which people enjoy in a new country with a good climate where the population has not yet become dense.

Pacific Islands

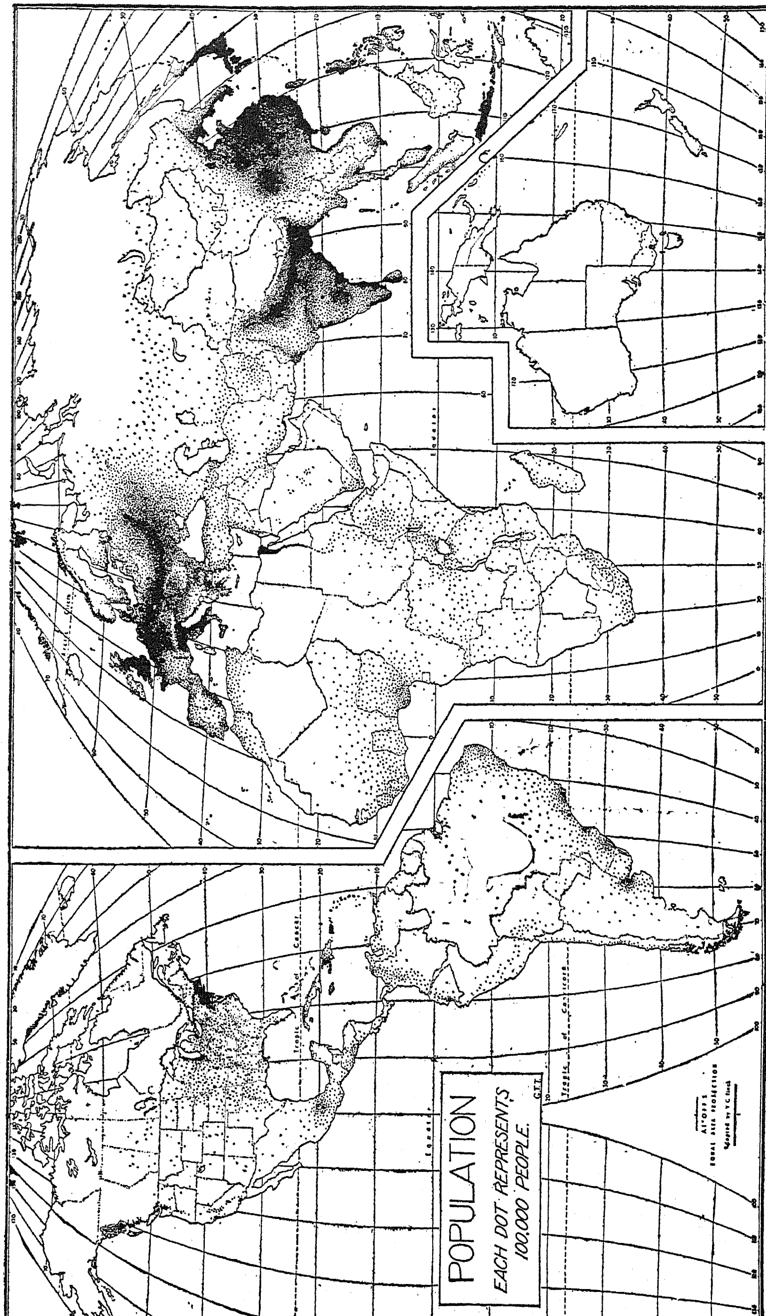
Between America and the big islands of Japan, the Philippines, New Guinea, and New Zealand, the Pacific Ocean is dotted with thousands of smaller islands, lying mainly within the tropics. Taken all together, the 2,650 of them large enough to be named separately are about like our state of Washington in area (70,000 square miles) but only two thirds as populous (about 1,100,000). They are divided into two distinct types, low coral islands, or atolls, and higher volcanic islands of all sizes from mere points of rock up to New Caledonia north of New Zealand (6,450 square miles); Hawaii, the largest of the Hawaiian Group (4,210) and Viti Levu (4,111), largest of the Fiji Group. These larger islands are comparable to our state of Connecticut (5,000 square miles), but their populations are much smaller, only 60,000 in New Caledonia and 400,000 in Hawaii. One reason for such small populations is that most of the volcanic islands are extremely rugged. On Tahiti a peak 8,000 feet high is

so steep that it has never been climbed. Large sections of many islands are utterly uninhabitable. Moreover, people depend almost entirely upon agriculture or fishing; there is little commerce and practically nothing in the way of modern industry.

The most important of the Pacific Islands are the Hawaiian Group, with five main islands close to the Tropic of Cancer and about 2,000 miles from Los Angeles and San Francisco. All are high, volcanic, and rugged. Their volcanic soil is fertile, but their value for agriculture varies because of great contrasts in rainfall. On certain mountain slopes facing the tradewinds, the annual rainfall is about as high as in any part of the world, for example, 242 inches at Keanae Valley on the northeast side of Maui, with no month less than 16. Only 20 miles away the annual rainfall is 28 inches, and six months have less than 2 inches apiece, so that agriculture is not profitable without irrigation. Even within the suburban area of Honolulu the rainfall varies from about 10 inches at certain points near the sea to nearly 100 inches a few miles back among the hills. In some parts of Hawaii water from the wet, windward side is brought to the east side through tunnels under the mountains. Honolulu, on the dry south (leeward) side of Oahu, well toward the west among the larger Hawaiian islands, is the only large city among all the Pacific's 2,650 minor islands. A few thousand of its inhabitants are of European descent, but by far the larger number are Chinese, Japanese, Filipinos, Puerto Ricans, and others who came to the islands to work in the sugar fields, and who are now becoming part of a curiously mixed group of new Americans. Tourists love Oahu for its tropical vegetation and brilliant flowers, its sandy beaches with their sports of swimming, surf-board riding, and fishing, and its contrasts between marvelously productive fields of cane and pineapple and rough cliffs and crags. They seek the larger island of Hawaii to see its vast craters and active volcano.

The Hawaiian Islands extend northwestward 1,600 miles to Midway Island where the *China Clipper* comes to rest after the second leg of its long flight from Los Angeles. The next stop is at the little coral reef of Wake Island. Then another long leg brings the airplane to the higher island of Guam, from which the clipper flies to Manila.

At Honolulu the air route to New Zealand and Australia turns almost due south and heads for Canton Island near the equator in west longitude 170°. Then, turning more to the west, it goes to the large French island of New Caledonia. From there the distance southeastward to Auckland in New Zealand or southwestward to Sydney in Australia is nearly the same. From Canton it would be most interesting to fly southeastward across 6° of latitude to the Marquesas Islands which are ruled by France and are said to be supreme in the beauty of their people and their scenery.



From Elements of Geography, by V. C. Finch and G. T. Trewartha, McGraw-Hill Book Co.

A—World Map of Distribution of Population.

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Then one might turn southwest again to Tahiti in the Society Islands, and finally southeast once more to latitude 25° where the famous little island of Pitcairn supports the descendants of British sailors who a century and a half ago mutinied in the warship, *Bounty*, and fled with Tahitian wives to this small rocky speck in the midst of the vast ocean.

The natives of Hawaii, the Marquesas Islands, and Tahiti are Polynesians, a race famous for its beauty and for its marvelous ability as sailors and fishermen. The Maoris of New Zealand, almost the only uncivilized people that have been able to fight the white men on practically equal terms, are descended from people of this same race who migrated in open boats 2,500 miles from Tahiti. The Polynesians seem quite "European" in appearance and in many other qualities. They are very different from the negroid Melanesians who live in the western islands of the Pacific, especially the Solomon Islands near New Guinea, and New Caledonia and the New Hebrides between Fiji and Australia.

QUESTIONS, EXERCISES, AND PROBLEMS

1. On a good-sized outline map insert in their proper places the names of all states, cities, rivers, lakes, and mountains of the United States mentioned in the text. Now put this map aside and take another which has no names. Without referring to any map, see how correctly you can (*a*) name all the states and (*b*) locate the cities of over 250,000.

2. On another outline map indicate the density of the railway net by the following shadings: dense, solid blue; medium or mixed, blue lines; sparse, red. For each main section of your map state the main reasons why a special type of shading is appropriate. For example (1) the density in solid blue states may be due to such factors as manufacturing, plains, farming; (2) open spaces in states with blue lines may be due to physical features such as the Ozarks or Adirondacks, aridity, glaciation, swamps; and (3) scarcity of railroads may be due to such factors as mountains, aridity, high plateaus.

3. Repeat Exercise 1 for the provinces of Canada.

4. The nine Rocky Mountain States have a slightly larger area than Mexico. How do they compare with Mexico in (1) population, (2) approximate railway mileage, (3) land available for crops, (4) number and distribution of cities with more than 50,000 population? (Data in *Statesmen's Yearbook* and in *Statistical Abstract of the United States* under "railways," "farms," "cities," etc., will help you.) From a comparison of these figures what conclusions do you draw as to the effect of relief, climate, and stage of culture on these four conditions and on general progress?

5. On an outline map indicate the location and names of large South American seaports in blue and of large interior cities in red. Shade the parts of the map where the dots in A144 indicate a dense population.

6. Compare the railway maps of North and South America making a list of (*a*) resemblances, and (*b*) differences which arise from the following conditions: (1) temperature, (2) longitudinal valleys and coastal mountains, (3) high plateaus, (4) plains, (5) tropical forests, (6) other conditions.

CHAPTER VIII

COUNTRIES OF EUROPE

Europe differs from North and South America in having mountains which trend east and west instead of north and south. The high mountains of the south are young like those of the west in America. Thus in a certain way the Sierra Nevada and Pyrenees of Spain, the Alps of Switzerland, the Apennines of Italy, the Carpathians of Slovakia and Rumania, the various Balkan ranges of Yugoslavia, Albania, Bulgaria, and Greece, and the Crimean and Caucasus Mountains of Russia form a system corresponding to the coast ranges, Sierra Nevada, and Rocky Mountains in North America. North of this lies a band of lower, older, more gently sloping mountains. These are followed by the most important part of Europe, a plain or gently rolling lowland extending from southern France and southern England through Belgium, the Netherlands, Denmark, southern Sweden, Germany, and Poland to the Baltic States and Russia. In Belgium it narrows to only about 100 miles, while in Russia it expands to a width of 1,600 miles or more. This plain corresponds to the great interior plains of the two Americas, but runs east and west instead of north and south. In view of the shallowness of the water, we may almost say that the plain includes the English Channel and the North and Baltic Seas. Finally, north of these bodies of water the old mountains and plateaus of Wales, Scotland, and Scandinavia correspond to the Laurentian Highland and Appalachians of North America, but do not isolate the European plain from the sea to any great extent.

The difference between the Americas and Europe in the trend of the mountains and plains is of the utmost advantage to Europe. In the first place, because the coast of Europe trends northeastward instead of northwestward, as on the west side of America, the warm water of the Gulf Stream, after it spreads out as the Atlantic Drift, is able to penetrate to the northern point of Europe and beyond, thus warming the entire coast in winter. In the second place, the open lowland between the Scandinavian highland and the Alps permits the dominant west winds to blow hundreds of miles into Europe without losing too much of either their winter temperature or their moisture. This makes Europe as

habitable in latitude 50° as the United States is in latitude 40°. It causes the climate within two or three hundred miles of the ocean, or even of seas such as the Baltic, to have much warmer winters than would otherwise be the case. In January Leningrad is 35° F. warmer than the same latitude west of Hudson Bay.

Scandinavia and Finland

Both physiographically and humanly there is good reason for putting Finland with Norway and northern Sweden. Although physiographically the Danish plain resembles only the southern part of Sweden, its people are so like those of Norway and Sweden that the three countries form a compact group. Hence we may rightly speak of Fennoscandia as a unit including Denmark, Norway, Sweden, and Finland.

Norway furnishes a good example of old mountains long ago worn down to gentle relief, but now uplifted into a high plateau and dissected. As a result the country is very rugged, and only five railroads cross it from east to west in A568. Large parts of its broad southern plateau stand at a height of more than a mile. There an old topography of well-rounded hills and mountains forms a strong contrast to a young topography of steep-sided valleys cutting into the plateau from all directions, especially the west. Glaciers have deepened the valleys and steepened their sides so that their drowned outer ends often form beautiful, sheltered fiords bordered by cliffs down which the streams leap in waterfalls. In such a country there is little room for cities or even villages. Even such minor cities as Trondheim and Bergen can scarcely find room between the western seacoast and the mountains. The largest Norwegian lowland, near Oslo, in the southeast, is a small place and decidedly hilly. Norway is so rugged, so high, and so cool in summer that even such energetic people as the Norwegians have made only small parts of it accessible by rail, or even by motor. With so few opportunities inland, it is small wonder that the Norwegians have taken to the sea.

Sweden consists of two parts; one is a section of the Norwegian plateau which slopes gently eastward to the Baltic Sea, the other a southern lowland. Both are full of glacial lakes and moraines. On the west the plateau is mountainous and almost uninhabited except by lumbermen in the great forest and iron miners and a few Lapps in the north. Toward the coast the hills become gentle and there is some farming. The southern lowland is quite hilly in places, but has a good deal of flat land and is well farmed. It begins north of Stockholm and includes that city and Göteborg, the only other large Swedish city. The moderate, but not extreme density of the railway net is appropriate to an agricultural population.

Denmark is much like the extreme south of Sweden. In few other countries is the whole area so nearly level and so largely cultivated. Nevertheless, gently sloping hills rise to a considerable height, and the relatively sandy west side is sparsely populated. Copenhagen, like Stockholm, is one of the world's most attractive cities. It owes its growth partly to the fertile soil of the island of Zealand and partly to the fact that it is located where the main route from Denmark to Sweden crosses the sea route which gives Sweden, Finland, Russia, the Baltic States, and Germany an outlet from the Baltic Sea through the straits of Kattegatt and Skagerrak to the North Sea. Such a crossing place in the midst of the world's most active nations is bound to be important.

Finland, lying east of the Gulf of Bothnia and north of the Gulf of Finland, is part of the same old, worn-down mountain land as Norway and Sweden, but it has not been much uplifted. It has been so thoroughly glaciated that it consists largely of lakes, swamps, bare rocky hills, and gravelly moraines with small flat hollows and plains scattered among them. Although there are no mountains, large parts of the country are so rugged that again and again the motorist finds himself at the top of a little hill where the slope changes so suddenly and the road makes such a curve that the road ahead of him disappears for a moment, and his radiator seems to hang in mid-air. The people are mainly farmers and lumbermen who live mostly in the south, where the capital, Helsinki, is located. The north is left largely to pine forests. Widely spaced railroads with a hint of a dense net in the south tell the story. All four of the Fennoscandian countries are impressive because their people maintain such high standards of comfort and progress in spite of scanty natural resources.

Great Britain

Aside from its character as an island off the west coast of Europe and as a place having one of the world's best climates, perhaps the most noteworthy physical feature of the geography of Great Britain is the contrast between the northwest and the southeast. In the north and west the land is high and rugged, the rocks are old and contorted; the population is sparse, poor, and relatively backward; railroads and motor roads are scarce. From northern Scotland southward to London there is more or less steady change toward a gentler topography, lower hills, younger and less contorted rocks, more widespread agriculture, a greater amount of manufacturing, a more highly developed transportation system, and greater wealth and commerce. The steadiness of this change is broken by the narrow strip of the Scotch Lowland where the great residential, commercial, and governmental city of Edinburgh and the

still greater industrial city of Glasgow rise to the highest cultural levels. The number of railroads crowded into this little band of country is astonishing (A568).

South of the Scotch border in England the coasts begin to be bordered by lowlands and one finds two sets of cities. One set consists of seaports, the largest of which are Liverpool, Cardiff, and Bristol, on the west; Newcastle, Hull, and London on the east; and Portsmouth and Southampton on the south. The other set consists of industrial cities surrounding the hills of the low central Pennine Chain which juts south from Scotland. The largest of these cities include Manchester, near Liverpool, then Birmingham, south of the Pennine Chain, and Nottingham, Sheffield, and Leeds on its east side. East and south of these last cities England consists of a lowland, quite flat on the east, but hilly enough to be interesting elsewhere. Here the chief cities are the seaports already mentioned. From mountainous and sparsely populated Wales to London in the lower valley of the Thames, the change in the relief of the land, the character of the rocks, and the density, occupations, and prosperity of the people is much the same as from northern Scotland to London. On the whole the population is becoming less dense from decade to decade in the highlands of Scotland and Wales, whereas in and around London it increases faster than in any other main section of Great Britain.

Ireland

Ireland, like Sweden and Britain, is a transition country belonging partly to the old mountain land of the north and partly to the plains of central Europe. The Irish mountains are low and rolling and in some places are surrounded by the plain. On the whole, however, they lie near the borders of the country, leaving the center as a poorly drained lowland full of large lakes and bogs. Western Ireland, like the western parts of Britain and Norway, is too wet and oceanic for profitable agriculture. Hence most of the Irish live on the east side of the country. Northeastern Ireland, which is politically united with Great Britain, contains the densest population. There the area near Belfast, one of the two main cities, has a remarkably dense railway net. In the rest of Ireland the region around Dublin has the densest population, but there are many people along the south coast.

France

One of the unique features of France is that it is the only European country which includes parts of all three main physiographic divisions. In Brittany, which juts out farthest west, and to some extent in Normandy just east of this, we find a low but rather rough country belonging to

the ancient mountain systems of the north. The snowy Pyrenees on the south and the still higher Alps on the southeast are high young ranges like the Sierra Nevada of California. Mont Blanc, the highest point in Europe (15,781 feet) lies in France. Much of the rest of France is a plain, but the high young mountains of the south are flanked by older, lower, gentler mountains, forming a series of plateaus farther north. Fortunately for France these other mountains are separated from both the Pyrenees and the Alps by easily traversed lowlands, and are themselves readily accessible, as appears from the great number of railroads in A568. They include the Auvergne, a broad plateau which rises to a height of 3,000 feet or more in south central France, and is capped by the cones of old volcanoes, long extinct. Many rivers radiate from this area, including the Seine and Loire. From the plateaus the land slopes down gently in most directions, but steeply toward the Rhone Valley on the east.

Around the central French plateau the lowlands form a large elliptical band, broad at the north, narrow at the south, but everywhere easily traversed and a good place for farms and cities. France has few mountain barriers to divide it into diverse sections. Nor has it any extensive regions of backward or sparse population, as is evident from the railroad map. The largest cities, as might be expected are located in the plain. There in the far north, close to Belgium, we find Lille, one of the few thoroughgoing industrial cities of France. Farther south Paris lies in the center of a basin, surrounded by more or less circular lines of hills which slope gently on the side toward Paris, but are steep on the other side. This difference in slope is especially evident east of Paris, where the steep outer slopes of these cuestas, as such hills are called, helped to protect Paris from the Germans in the first World War. Although boats navigate the Seine past Rouen to Paris, Paris is not a seaport. Nevertheless, it behaves like one in many ways, for Havre at the mouth of the Seine, Dieppe a little to the east, and Cherbourg on the next peninsula to the west exist mainly for the use of passengers or freight bound to or from Paris. Southampton and Plymouth far to the west serve similarly for London.

In a circuit of the elliptical French plain one avoids the higher land of Normandy, straight west of Paris, and crosses the hospitable, gently rolling chateau country to Nantes at the mouth of the Loire. Then, as may be clearly seen on a relief map, one traverses a similar plain to Bordeaux at the mouth of the Garonne. Following still the elliptical lowland one ascends the Garonne to another great city, Toulouse. There the lowland becomes narrow, being compressed between the Pyrenees, and the wild Cevennes, or southern part of the Central Plateau. Nevertheless the plain continues along the Mediterranean coast as far as Mar-

seille, the greatest French seaport. Farther east the Alps replace the plain along the rugged Riviera coast. There Nice has become a great city because the Riviera is such a beautiful resort in both winter and summer. Going back to Marseille one travels north up the Rhone Valley to find the narrowest part of the lowland at the silk city of Lyon. Farther north at the head of the Saône Valley the lowland divides. One fork crosses by a low pass at Belfort into the Rhine Valley on the northeast; the other passes through rolling hills northwest toward Paris. The ease with which one can travel from the Mediterranean Sea up the Rhone Valley either to northern France or western Germany had a great deal to do with bringing Roman civilization to Western Europe and with causing the French to become a so-called Latin people, speaking a Romance language.

In many ways France is most fortunate. Its northern part, with the invigorating North Sea type of climate, is almost unexcelled from the standpoint of health and activity. In southern France the climate is less stimulating, but most delightful, especially in the Riviera. France has the further advantage of facing on both the Atlantic Ocean and the Mediterranean Sea. Then, too, the fact that France and England lie close together, but are separated by the Strait of Dover at Calais, prevents them from quarreling about boundaries, and helps them to be friendly. So far as the French boundaries are formed by the Atlantic Ocean, the Pyrenees, the Mediterranean Sea, the Alps, and the Jura Mountains north of Lake Geneva, they are excellent. Between the First and Second World Wars, however, a bad boundary was located along the Rhine from the Swiss city of Basel past Strasbourg. When people were primitive and had difficulty in crossing rivers, the Rhine was a good boundary. Now it is a poor boundary because it is a great artery of traffic, easily crossed, and the people on the two sides ought to have much to do with each other. Unfortunately, however, those on one side are French and on the other Germans. The present eastern and northern boundary of France is fairly good from the physical standpoint where it runs along the eastern plateaus past what used to be the little independent duchy of Luxemburg. When Belgium is reached, however, the boundary crosses the open plain, thus exposing France to easy invasion from Germany, as has happened in both World Wars. The whole eastern and northern boundary is undesirable because much of it fails to agree with the distribution of languages, customs, and national sympathies.

The Low Countries

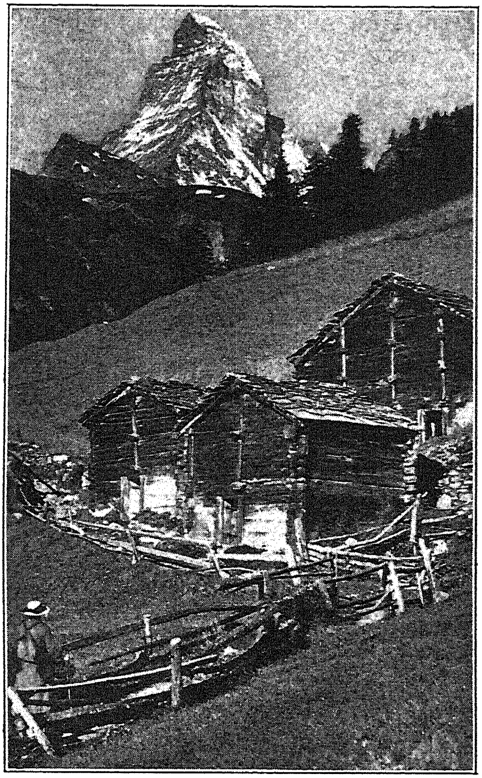
For a long time Belgium and the Netherlands were two of the world's most favored countries, except that they were far too small and had poor

boundaries. Each is about the size of Massachusetts and Connecticut. Each has over 8 million people—2 million more than those two states combined. Together they equal West Virginia in size, but have ten times as many people. Belgium and the Netherlands have grown populous because of a level plain, fertile soil, an unexcelled climate, energetic people, and a location close to the North Sea, the English Channel, the mouth of the Rhine, and the three great countries of Germany, France, and Britain. They have been handicapped because their land boundaries everywhere lie in the level plain or among hills so low that they can be easily crossed. Because higher hills lie southeast of this narrow section of the plain, armies have repeatedly moved through the Low Countries, instead of directly across the hills between Germany and France. This happened in the wars of Napoleon, the first World War, and still more fully in the Second World War. The Netherlands includes the mouth of the Rhine, which is Germany's most important river. Its seaports give direct access to the most frequented part of the North Sea. Hence in 1940 the Germans insisted that the Netherlands must become part of the German "Reich," or new empire. In spite of this handicap these little countries stand at the forefront in manufacturing, commerce, prosperity, and general progress. A large part of their people—about half in the Netherlands—live in cities of 20,000 or more inhabitants. Brussels in Belgium is one of the world's few cities of close to a million people, and Antwerp is large. No Dutch city equals Brussels in size, but Amsterdam, Rotterdam, and The Hague each have half a million or more people. Rotterdam, Amsterdam, and Antwerp are great centers of trade, especially with colonial possessions. Until 1940 the two Low Countries followed next after France and Great Britain as possessors of large and valuable colonial possessions in the tropics.

Switzerland

Although Switzerland is an Alpine country, most of the Swiss do not live in the Alps. From the Mediterranean Sea between Nice and Genoa the great arc of those mighty mountains swings around to the head of the Adriatic Sea near Trieste. Only a third of the Alps lies in Switzerland, but this is the part which tourists chiefly see. It is one of the world's greatest playgrounds in both summer and winter. The main work of Switzerland, however, is done in a broad, hilly valley north of the Alps at a height of 1,500 to 2,000 feet above the sea. The valley extends from Lake Geneva on the west to Lake Constance (the Boden See of the Germans) on the east. On the north it is bounded by the Jura Mountains, which are low compared with the Alps, although many peaks rise well above 5,000 feet. It is full of beautiful lakes—Neuchâtel, Zurich,

Lucerne, and Interlaken. Two other famous Swiss lakes, Lugano and part of Maggiore, lie at the southern base of the Alps where the boundary of Switzerland leaves the main mountains and dips far south. The beauty of many of the Swiss lakes arises from the fact that one end lies deep within the Alps at the base of precipitous, glaciated cliffs, while



A—The Heart of the Alps.

This picture shows 5 features that are highly typical of the Alps.

(1) The sharp, glacier-cut peak of the Matterhorn; (2) a coniferous forest; (3) a sloping hayfield; (4) isolated sheds for dairy cattle and hay; and (5) a hiker with a knapsack.

the other lies out in the lowlands where the water laps against the rounded hills of old moraines.

Water power is almost the sole mineral resource of Switzerland, and agriculture is hampered by the coolness of the summers. Nevertheless, few other countries are so steadily prosperous and highly industrialized. As a rule the industrial cities and villages are small. Only Zurich in eastern Switzerland has over 200,000 inhabitants. The density and

activity of the population, however, are evident from the railroad map. The Alps, to be sure, form a band of light shading there, but the lowland, where most of the Swiss live, has about as many railroads as any part of the world. Moreover, the Alps themselves are repeatedly crossed by railroads which penetrate under them in long tunnels. The great activity and prosperity thus indicated became especially impressive when one notes that even in the midst of the Alps the density of the railway net is much greater than in the open plains of Russia.

Germany

Measured by the number of people old Germany, as it was before the Second World War, was one of the world's largest countries—almost half as large as Russia. Measured by area, however, Germany is a small place —about one thirtieth the size of Soviet Russia and one tenth the size of the United States. This older "German" Germany has three main parts: (1) the high Alps, occupying a small area in the south; (2) a series of relatively old mountains of moderate height and rather gentle slope extending north beyond the middle of the country; and (3) a broad northern plain. From the Alps the land descends sharply to a height of 2,000 or 3,000 feet or less, where a confused mass of old mountains begins. On the west the so-called Rhine Graben is a lowland where a long narrow block of the earth's crust has fallen inward, giving rise in due time to a valley nearly 200 miles long but only 10 or 20 miles wide. East of the Graben the Black Forest, 5,000 feet high in places, runs northward, separating the Neckar and Danube basins from that of the Rhine. North and east of this many other, smaller mountain ranges kept the people apart in former days, although now both railroads (A568) and motor roads are so common everywhere that the old isolation has largely disappeared. The most conspicuous division arising from the mountains is the diamond-shaped area of old Bohemia, the Czech part of the former country of Czechoslovakia. One of the new Germany's greatest troubles has been that the people in separate units such as Austria, Bavaria, and Bohemia have different ideas, and some of them, for example the Bohemians, differ from the Germans in race and language.

North of the old central mountains the German plain with an average width of about 150 miles is fairly level at first, but farther north consists of rough glacial moraines covered with pine forests and studded with many lakes. The section of the German people which has been able to spread out and unite the others into a single country has been the Prussians, who lived in the eastern part of the plain. The ease with which they could travel across the plain probably helped them to become dominant.

The climate of Germany varies less from north to south than from west to east. This is because the country as a whole slopes upward from north to south, and becomes more continental from west to east. Thanks to the slope the temperature in the parts where people live is about the same at all latitudes. In both summer and winter the port of Stettin in northern Germany on the Baltic Sea has the same average temperature as Friedrickshafen on Lake Constance 450 miles farther south. On the other hand, west winds from the ocean warm northwestern Germany so much in winter that the climate is very different from what it is farther inland. Although Bremen lies more than 14° of latitude north of Baltimore, it has the same January temperature, 33°. As one goes directly eastward from Bremen, the winters become colder until at the eastern border of Germany the average is only 22°. The summer becomes somewhat warmer, with a July average of 65° instead of 63°.

So great a country as Germany naturally has many large cities. One group consists of seaports, most of which are located at the mouths of rivers. On the west, Bremen lies on the Weser River nearly 40 miles from its mouth and from the subsidiary port of Bremerhaven where the largest steamers have to land. Only 60 miles from Bremen the much greater port of Hamburg is located at the mouth of the Elbe River. With its suburbs of Altona and Harburg it has a million and a half people. About 60 miles to the north Kiel lies on the Baltic coast at the end of the Kiel Canal which cuts across the peninsula of Denmark. Farther east the great port of Stettin has grown up on the Oder River far back from the open Baltic, while Königsberg in East Prussia (the northeast corner of Germany) is on a smaller river. Thus Germany has two great ports facing the North Sea, two facing the Baltic, and one, Kiel, which belongs to both seas. The North Sea ports, however, are much the larger and more important. All the main German ports except Kiel lie well back from the sea, and thus are protected from naval attack in time of war. Even Kiel lies at the head of a narrow bay ten miles from open water.

Where a plain lies between highlands and the sea, the two most favorable places for cities are generally at the mouths of the rivers along the seacoast, and at the inner edge of the plain where rivers flow out of the highlands. We have just seen that the German seaports are mainly located in one of these types of places. Between the seaports and the edge of the highlands there are no German cities of more than 200,000 population except Berlin (4,500,000). On the border of the plain, however, in western Germany alone the following cities of more than 300,000 inhabitants lie in a curve around the base of the highlands: Cologne, Düsseldorf, Wuppertal, Duisburg-Hamborn, Gelsen-kirchen, Essen,

Bochum, and Dortmund, together with ten other cities of more than 100,000 population. The reason for this remarkable concentration is primarily the coalfields, but there would be an unusually dense population even without them. The soil is especially rich, the climate is of the best, the Rhine furnishes an excellent means of water transportation, and canals can easily be built in other directions. Thus this little area is one of the world's most favored places. In the past its chief handicaps have been that it had to bring iron from what were then foreign sources, such as Lorraine in eastern France, Haparanda in northern Sweden, or Bilbao in northern Spain, and that it was cut off from the ocean and the mouth of the Rhine by the Netherlands. The Second World War has altered these conditions considerably.

East of Dortmund other big German cities lie along the irregular line where the hill country joins the plain. Among those with more than 200,000 people Hanover lies farthest west. Then come Magdeburg, Halle, Leipzig, Chemnitz, and Dresden. Breslau on the Oder may also be counted as belonging to this irregular line.

Farther south within the highlands each large city is generally the center of its own more or less isolated valley. Mannheim is the largest city directly in the Rhine Graben, although Strasbourg on the west side is also large. Frankfort, however, although on the Main River, is the chief town of this region. Stuttgart, farther south on the Neckar River, is the center of another valley in Württemberg. Farther east **Nürnberg** and especially Munich are the great centers of the elevated plateau of Bavaria, while Vienna, one of the world's greatest cities, is the chief town of a distinct section of the Danube Valley. Prague (Praha) on the Elbe River is the main city of the especially well-defined Bohemian diamond with its wall of mountains, and Brünn (Brno) occupies a similar position in the valley of the Morava (the district of Moravia). These last two cities belong to the Czechs, not the Germans.

Three Polish cities, Posen, Warsaw, and Lodz, which lie in the open plain north of the highlands, were under German control during the second World War. The Polish cities of Krakow and Lwow belong to the highland border type.

Germany has suffered because cities and provinces were pulled apart and, after unification, because its boundaries were not well defined. One of the greatest troubles of our time is that Europe's linguistic, cultural, and political divisions harmonize neither with natural geographic regions nor conditions of modern transportation and commerce. From these points of view the whole region from France and Switzerland to Poland and Denmark ought to be a single cultural unit.

Soviet Russia

The Union of Socialist Soviet Republics is as large as the whole of North America with Colombia and Ecuador thrown in for good measure. Nevertheless, the actual capacity of the country to support population is less than that of the United States. The railroad maps (A568 and A569) illustrate the matter. Railroads are one of the best measures of the degree to which a country produces commodities that enter into trade. On the map of European railroads note how many places there are where a country the size of Denmark or Belgium could be set down on Russian soil without touching a single railroad. In Asia the whole of the well-inhabited part of Europe (the part where there is any kind of *network* of railways) could be set down in unoccupied territory north of the Siberian railway, as well as south of it. All the railway maps of continents, it should be noted, are on the same scale.

The Russians have failed to occupy the whole of their country in spite of the fact that much more than half the land consists of plains and gently sloping lowlands. The northern parts, however, are so cold, the south central parts east of the Caspian Sea and the lower Volga are so dry, and a large part of eastern Siberia is so high and therefore cold that the area fit for agriculture is scarcely larger than in the United States. Moreover, the Russian area has so cold or dry a climate that even with the best cultivation it will not yield so much per acre as the farms of the United States. Then, too, although the mineral wealth of Soviet Russia is great, it is far less abundant than that of this country. It is also difficult to extract because many deposits are small, poor in quality, or located in remote inaccessible regions.

The Russian plain begins on the western border of the U.S.S.R. in old Poland. In the south it extends eastward past the Black Sea and the salt lakes known as the Caspian and Aral Seas until it reaches the huge mountain ranges of Tien Shan and Altai. Farther north the plain is interrupted in the middle by the low, gently sloping Ural Mountains, but beyond these it continues eastward even farther than in the south. Starting at the Baltic Sea and going toward Lake Baikal one can travel more than 3,000 miles without seeing any mountains or even high hills except the Urals. East of the Sea of Aral one can do the same thing along a north and south line for almost the same distance. Nowhere else does the world have any such vast plain.

The plain is by no means uniform. To one starting in the Ukraine north of the western part of the Black Sea and traveling east, the country at first looks not unlike the plains of Minnesota. As one approaches the Caspian Sea, however, trees disappear, and in due time fields give place to pastures covered with short grass. East of the Caspian Sea these in

turn are replaced by yellow deserts with sand dunes higher than houses, or by mile after mile of naked gravel or bare clay. If one goes north from the Black Sea he travels first over a prairie-like country with deep rich black soil. In the course of a thousand miles the soil turns brown, and grasses give place to trees in the uncultivated places. Irregular hills, small lakes, and swamps indicate that the country was once glaciated. Cultivated fields become scarce, and at length the whole of the mildly hilly plain is covered with coniferous forests. Near the Arctic Ocean the trees diminish in size, and for the last hundred miles or more one's feet sink deep in the mosses and lichens of the open tundra or slip in the mud of its wet holes.

Although the plain is the main feature of Soviet Russia, no other country has such vast areas of mountains, and few have peaks much higher. On the south much of the U.S.S.R. is bordered by young, rugged mountains of the same type as the Andes. The beautiful Crimean Peninsula contains the western outliers of the Soviet mountains. Then comes the lofty Caucasus with the Armenian highland rising south of it. Between the two lies a picturesque valley with Batum embowered in trees and flowers at one end, Tiflis on its castled hills in the middle, and the huge ugly, greasy city of Baku sprawled out at the other end in a depressing waste of desert beside the Caspian Sea. An iridescent film on the Caspian proclaims that Baku is a great oil city. On the south side of the Caspian the beautifully forested slopes of the great Elburz Range rise abruptly to the Persian Plateau. This range continues eastward, keeping Persia and Russia apart. Along the Afghan border of the Soviet Republic the mountains become still more high and wild until the lofty Pamir Plateau is reached, not far from the center of Asia. South of brackish Lake Balkash the Tien Shan Plateau is almost equally high. Farther east the southern border of Siberia is mountainous until the great Amur River is reached. Moreover, the whole of Siberia east and north of Irkutsk and Lake Baikal is a land of cold plateaus and mountains. It is full of gold and other minerals, but much of it is uninhabited and only roughly explored.

Among the larger Russian cities only five are seaports, and two of these barely reach a population of 200,000. In the far north, on the shores of the White Sea and almost in the tundra zone, the Russians have persistently developed the port of Archangel. No other seaport of any such size has such a struggle against ice. This is one reason why in 1940 Russia struck westward in an attempt to secure a passageway across Finland to an ice-free port in northern Norway. Leningrad, too, although one of the world's greatest seaports, with about 3 million people, is much hampered by ice. This helps to explain why Russia tried to get

political and military control of the Baltic States in 1939. Their islands and ports are not so icy as is the mouth of the Neva River at Leningrad. On the Black Sea Russia has two large ports, Odessa and Rostov, each with half a million inhabitants, and there are several minor ports of fair size. To find another large oceanic port belonging to Russia we have to go 5,000 miles eastward to Vladivostok on the Sea of Japan. The whole vast Soviet Republic has not a single seaport as good as London, Amsterdam, Hamburg, Marseille, or Naples.

The situation is not so bad when we consider inland ports on lakes and rivers. At the port of Astrakhan where the Volga enters the Caspian Sea the oil of Baku is transferred to river boats and shipped up the Volga to Stalingrad, Saratov, Kiubishev (formerly Samara), Kazan, and Gorki, as well as many smaller cities. Gorki used to be Nijni Novgorod, famous for its fairs. Even the huge capital city, Moscow, with its 4 million people, can be reached by canal from the Volga. Ships sail on many other rivers such as the Don and Dnieper in European Russia. The two greatest cities of Siberia have grown up where the Siberian railroad meets the river transportation of the Irtysh at Omsk and of the Ob at Novosibirsk. The Yenisei River, too, and its branch, the Angara, have similar but smaller river ports at Krasnoyarsk and Irkutsk. The far northern Lena, however, flows through so cold a country that it still remains almost unused, although larger than the Missouri.

Like other countries, Soviet Russia has its mineral cities, such as the oil cities of Baku, on the south side of the Caucasus Mountains, and Grodny and Krasnodar on the north side. Measured by their size, the oil cities surpass the coal and iron cities, among which Kharkov and Stalin north of the Sea of Azov are the chief. The minerals of the Ural Mountains, especially the iron, have helped in the growth of Sverdlovsk, Chelyabinsk, and Magnitorgorsk, the last being so named because of its magnetic iron ore. The other large cities of Russia are mainly manufacturing centers located south or southwest of Moscow. The manufacturing cities not yet mentioned which contain more than 200,000 inhabitants include Tula, Voronezh, Kiev, Dniepropetrovsk, and Zaporozhie. The last two lie close to the famous water-power project where the great Dnieper River has been dammed. Water power is scarce in Soviet Russia because mountainous districts are mainly located far from a dense and active population, and largely in regions where the temperature is so low that power projects are greatly hampered.

Three Soviet cities, in addition to Moscow, are conspicuous as capitals. Beautiful Kiev, with its famous old monasteries, is the capital of the Ukraine Republic. Tiflis, the capital of the Georgian Republic, occupies a most picturesque location on steep hills in a narrow valley where the

only feasible road across the Caucasus, by way of the Dariel Pass, crosses the great highway from Batum on the Black Sea to Baku on the Caspian. The third capital is Tashkend, a thoroughly Asiatic city lying on a sunny irrigated plain embowered in poplar, willow, and fruit trees. It is the capital of the Uzbek Republic.

Such republics, within the main republic of the U.S.S.R., are somewhat like our states, but are divided according to race and language rather than geographically. The largest one, which rejoices in the long name of the Russian Soviet Federal Socialist Republic, includes most of the "real" Russians, and has a population of close to 110 million. Its nearest rival is the Ukraine Soviet Socialist Republic in the southeastern part of European Russia. The 30 million Ukrainians are closely allied to the real Russians, but speak with a different accent and like to call themselves Ukrainians. The White Russian Republic north of Ukraine is also inhabited by genuine Russians—6 million of them—with their own slight peculiarities of language and customs. Eight other republics, of 1 to 7 million Georgians, Armenians, Kirghiz, Uzbeks, Tadzhiks, Turkmen, Kazakhs, or other non-Russian people, are located in Asia.

The Baltic States and Poland

Between the first and second World Wars a line of "buffer" states separated Western Europe from the Soviet Republic. Beginning with Finland on the north, they included the three little Baltic States, Poland, and Rumania. The relative location of the Baltic States follows the alphabetical order from north to south—Estonia, Latvia, and Lithuania. These three states and Poland lie in the European plain with little except the race and culture of their people to separate them from Russia. In large sections the scenery consists of glacial moraines, lakes, and swamps interspersed with fields, or with pine forests where the soil is especially poor or the land rough. Before the first World War the Baltic States and Poland were the part of old Russia where progress was greatest. Talinn (Reval) in Estonia, Riga in Latvia, Warsaw and Lodz in Poland, and even Vilna, which Lithuania claims as its capital, were more highly developed industrially than the Russian cities farther east. The same was true of Krakow and Lwów, in the Austrian part of Poland well toward the south. The prosperity and progress of the western parts of Czarist Russia were increased by the fact that the crops there are more productive than farther east. The European railway map (A568) illustrates the matter. East of the Baltic Sea, and in a curved band extending to the Black Sea, the net is less dense than in western Europe, but more dense than in Russia as a whole except for a little spot around Karkhov in the iron and coal district north of the Sea of Azov.

The advantages of the Baltic coast arise partly from the climate, which is more oceanic than farther east, and hence better for both people and plants. Riga lies farther north than Moscow, but averages 11° F. warmer in January temperature (24° against 11°). Riga also gets 15 per cent more rain than Moscow, which again helps the crops. A racial factor likewise enters into the matter, but we are not sure how much difference it makes. The Estonians, Latvians, Lithuanians, and Poles all differ in race from the Russians. Moreover, many Germans lived in the Baltic States and were generally leaders, until Hitler and Stalin agreed to move them into Poland in 1939.

Danubian and Balkan Countries

Six countries and part of a seventh form this division of our study, namely, Hungary, Rumania, Yugoslavia, Bulgaria, Albania, Greece, and the European part of Turkey. All these received new boundaries after the first World War. Examine a relief map in an atlas, or a wall map, and see what their physical features suggest as to political divisions. One of the main features is the curved Carpathian Mountains arching northward from the Danube east of Vienna and returning to the Danube again at the Iron Gate near the northwestern corner of Bulgaria. Inside the Carpathians lies a great plain which is cut into two unequal parts by hills near Budapest, and is interrupted in the east by the Transylvanian Mountains which fill the eastern bend of the Carpathians. On the south the plain is enclosed by an irregular mass of mountains and plateaus at the back of which lie the Dinaric Alps, the western base of which forms the picturesque drowned Dalmatian coast of the Adriatic Sea. There is no good name for all the mountains south of the central Danubian plain because they are so irregular and so broken into small ranges. Such irregularity is one of the great troubles of the Balkans.

Looking only at the topography, one would say that a good political unit could be created by using the Carpathians as a boundary from east of Vienna to the Iron Gate. Then the boundary would go south far enough to include the valleys that drain to the Danube. One of these valleys, that of the Morava River, which joins the Danube from the south near Belgrade, has been a frequent cause of strife because its branches offer the only easy paths to the south and east. One leads over a low pass to Sofia in Bulgaria, and thence to Istanbul and the Bosporous. The other affords the only good route to the Vardar Valley and thus to Salonika, the Mediterranean Sea, and Greece. The railroads in A568 show where these valleys are located. The eastern border of our hypothetical country might well be carried as far south as the watershed between the Morava and Vardar Rivers. Then let the boundary continue

westward to the Adriatic Sea north of Albania, northwestward along the Dalmatian coast to Fiume, and northeast to the starting point.

Such a physically unified country would be preposterous from the standpoint of human geography. It would include parts of Austria, Bohemia (old Czechoslovakia), Hungary, Rumania, and Yugoslavia. Its people would include Albanians, Bulgars, Germans, Magyars (Hungarians), Rumanians, Ruthenians, Serbs, Slovaks, and Slovenes. Each of these racial groups has its own language. Some of the languages, for instance Hungarian and Rumanian, are as different as English and Turkish. Each race or group also has its own special customs, and there are marked differences in religion and dress. Moreover, many know little of the other groups and do not like them. Each, too, is very tenacious of its own rights, and wants to preserve its own national heritage. The case is like that of the Irish in Eire (the Irish Free State) who are trying to revive their old language, to their own great detriment.

Let us go back to the map and see whether the mountains provide a framework for any other country. From the Iron Gate the Stara Pianina, or Balkan Range, swings east in a southward-bending curve to the Black Sea. Between this range and the eastern swing of the Carpathians lies the Rumanian basin of the lower Danube. Here again it would seem as if a good country could be made by using these two mountain ranges as boundaries and finishing the boundary by a line from the eastern end of the Carpathians eastward across the plain through the lakes and swamps north of the lower part of the Danube from Braila to the sea. But this, alas, would give us Bulgars south of the river, Rumanians north of it, and certain minor groups in the Carpathians and in the Dobruja, as the region east of the northward-flowing part of the lower Danube is called. The relief map, again, would make us think that a country with good boundaries might be established by combining the Maritsa Valley south of the Balkan Range with the seacoast of the Dardanelles, the Sea of Marmora, the Bosporus, and the Black Sea as far as the point where the Balkan Range comes nearest to the coast. Such an arrangement would put Bulgarians, Turks, and Greeks together, and long experience has shown that these diverse groups have hard work to get along peaceably.

The Macedonians illustrate the problem in still another way. They inhabit an area north of the Greek city of Salonika, some being in Greece, some in Bulgaria, and some in Yugoslavia. They all want to be united, and they would much prefer to govern themselves instead of being governed by Greeks, Bulgars, or Serbs. Their home is so mountainous that it is not easy for either of the three governments to keep them in order.

Many attempts have been made to solve the Balkan problem, mainly by force. After the first World War the changes illustrated in A568 were made. Bulgaria, having been on the losing side, had its wings clipped so that Rumania got the South Dobruja, Greece got Bulgaria's old outlet on the Aegean Sea, and Yugoslavia (old Servia) got various chips on the west. Rumania, having been on the side of the Allies, got Bessarabia from Russia, and Transylvania and part of the Banat from Hungary. Yugoslavia, also on the allied side, got a little from Bulgaria and a large slice from Hungary. Of course this made Bulgaria, Hungary, and Russia feel that they had been wronged. It also gave both Rumania and Yugoslavia much trouble because their expanded territories contained large minorities who did not like the way in which the majority ran things. Albania is too small to be a separate country and has fallen into the hands of Italy. The backwardness of this region becomes apparent when we discover that because of ruggedness and poverty a straight line drawn northwestward for 430 miles from the Gulf of Corinth in Greece does not cross a single railroad and only two or three roads that are passable for motor cars. What would we think if such conditions prevailed all the way from Pittsburgh to Chicago!

In some ways Greece appears to be the best human unit among the Balkan countries. This is partly because it is well bounded by seas and mountains and most of its people are Greeks. After the defeat of Greece by Turkey in 1920 about 1,400,000 Greeks were brought from Asia Minor to Greece in exchange for Turks who were taken to their own country. Greece suffers, to be sure, from poverty because it is so dry. Its drowned coasts, however, and beautiful deep bays and gulfs penetrating far into the gleaming limestone mountains give it commercial and fishing industries which are a great help. They cooperate with the high mountains of the country in turning the face of Greece to the sea and hence toward the west, so that it is less concerned with purely Balkan problems than are Bulgaria and Yugoslavia. Nevertheless, Greece has an intimate share in the chief Balkan problem of how to arrange matters when the boundaries between different kinds of people agree neither with the boundaries set by the geographical environment nor with those set by political agreement.

One solution of the Balkan problem would be to make the whole region into a single country. There is no evidence, however, that the various races would follow the example of Switzerland, where 3,000,000 people who speak German, 850,000 who speak French, 250,000 who speak Italian, and 45,000 who speak Romansch get along without quarreling. Another solution would be to move the various races around until each had its own territory in which a genuine geographic unit was occupied

by a single race speaking the same language and having the same customs, but this is far from easy.

Large cities are relatively scarce in the Danubian and Balkan countries, as is natural where most of the people are agricultural and comparative poverty is the rule. Budapest, with more than a million people is the only really large city of more than 200,000 people in Hungary, and there is only one other with more than 100,000. Bucharest in Rumania, with 650,000, is also the only large city there, in spite of a population of 20 million. The next largest Rumanian cities—six of them—have populations of only about 100,000. In Yugoslavia Belgrad has less than 300,000 people, and only two other cities go above 100,000, although the country has a population of more than 14,000,000. The three capitals that have just been named are located on or near the Danube River, which shows the importance of that river and its valley.

In Bulgaria, too, there is no great development of cities. Sophia, the capital, has less than 400,000 people, and only one other city has 100,000. In Turkey the great city of Constantinople, with three quarters of a million people, is too large for the scanty bit of Europe which goes with it. Istanbul, to use the official name, seems to have all the qualifications for the capital of a large country lying partly in Europe and partly in Asia. In Greece the cities seem to fit the country comparatively well, for with 6½ million people there is one city, Athens, which has half a million people when its port of Piraeus is included, and another, Salonika, in the north, with a quarter of a million. A third of the Greeks live in cities. The other Balkan countries show much lower percentages. For the Balkan countries as a whole, however, the great problem is not to build large cities, but to adjust their many languages and nationalities, and their political boundaries to their chaos of mountains, valleys, and plains.

Italy

The structure and problems of Italy seem simple in comparison with those of the Balkan countries. Bounded on the north by the high Alps and on the south by the Apennines, the basin of the Po River forms the most valuable part of Italy. There agriculture rises to a high level on a fertile plain, while great cities represent other types of human activity. There we find the only part of Italy in which the railway net (A568) has a density like that of England, France, and Germany. There, too, Turin and Milan are the great industrial cities of Italy. This is partly because they can get water power from the Alps, but mainly because industrial cities always tend to develop in cool climates more than in those that are warm. Farther east in the Po Basin, Bologna and Venice,

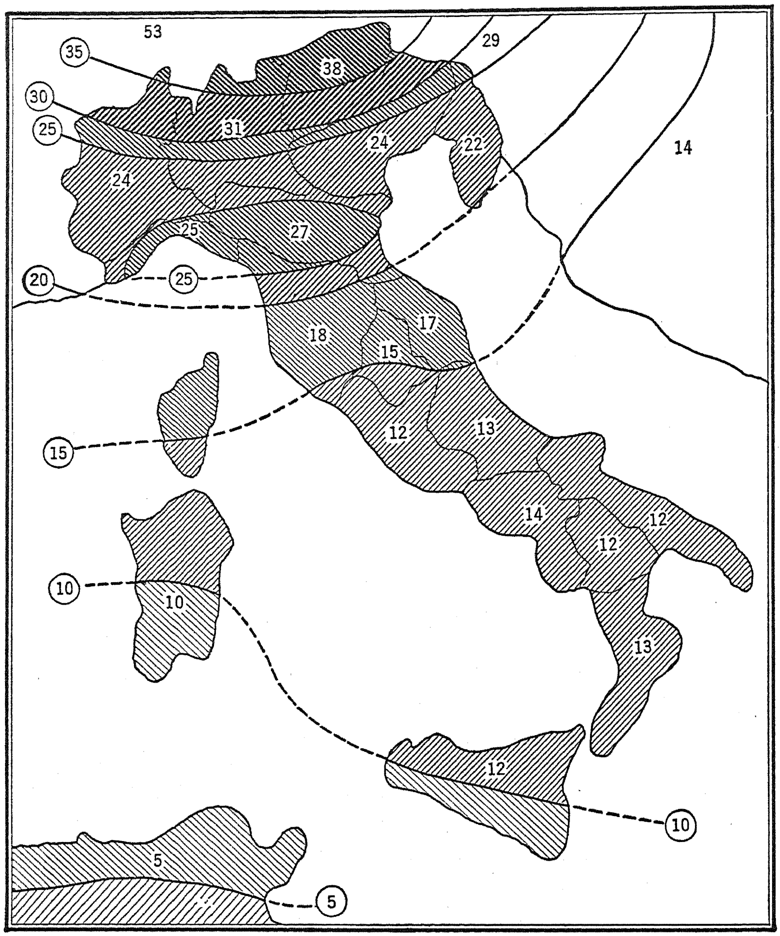
as well as smaller cities, represent the older Italy famous for its art and industry from the Middle Ages onward. The seaport of Trieste in far northeastern Italy lies just beyond the edge of the Po Basin. The still greater port of Genoa in the west is cut off from the basin only by a narrow band of mountains.

The peninsula of Italy consists of a backbone in the form of the Apennine Mountains, with a narrow fringe of coastal plain on the east and a wider, but nevertheless narrow, plain on the west. Two of Italy's greatest as well as most famous cities lie on the inner edge of the western coastal plain, namely, Florence (Firenze) on the Arno River and Rome on the Tiber. Naples, which follows Rome and Milan as the third largest Italian city, also lies on the western coastal plain. Its 900,000 people live close to the sea, with Vesuvius at their backs. On the entire east coast for 400 miles southeastward from Venice there is no large city until Bari is reached near the "heel" of Italy, and it has barely 200,000 people. The mountainous island of Sicily has three large seaports, Messina at the northeast corner, Palermo far west on the north coast, and Catania on the east coast directly south of the great volcano of Aetna. The presence of these three great cities is surprising when we note that the equally mountainous islands of Sardinia (Italian) and Corsica (French) have only one large city (Cagliari), and its population is only a trifle over 100,000. Sicily has large cities partly because ocean traffic through the Strait of Messina helps all three, but much more because rich volcanic soil around Aetna and elsewhere, and a fairly good rainfall on the north coast, enable a dense population to get a living.

One of the most interesting features of Italy is the contrast between north and south. If Rome, which lies midway from north to south, is counted with the north, all five of Italy's great inland cities lie in the north, as do three of the seaports. The south, on the other hand, has six seaports. This is like the contrast which we have found in both North and South America. Inland cities grow to large size mainly in the cooler climates which are well adapted to manufacturing. In warm climates commerce is the chief business of cities, and therefore seaports are the places with the most chance to grow.

A more significant contrast is seen in A166. This shows the productivity of the land when all crops are averaged. In getting the averages each crop is weighted according to its area. The price of each product per pound is assumed to be the same everywhere. The astonishing fact here is that in the north the productivity is two or even three times as great as in the south. The main reason is that the north, especially the Alpine valleys, enjoys relatively cool summers which have a fair rainfall instead of the hot and almost absolutely dry summers which prevail in

the south. This contrast, combined with the corresponding contrast in the development of manufacturing, shows how profoundly the geographical environment influences the prosperity and hence the character of the population. North and South Italy have the same government, speak the same language, have the same type of culture, and differ only



A—Agricultural Productivity per Acre in Italy.

a little in race. Nevertheless, the degree of progress is far less in the south than in the north. Much of this difference is inevitable because no amount of determination or education will enable the southerners to produce as much as the same people with the same determination and education could produce in the north. The soil as well as the climate makes it

impossible to get the same return for a given amount of effort and skill in both places. In this respect Italy is quite different from California, which it much resembles in other ways. The great difference is that California has a cool coast and considerable water for irrigation even in its southern portion.

Spain and Portugal

In Spain, just as in Italy, there is a marked contrast between the north, with good crops and a good deal of manufacturing, and the south, with poor crops and little manufacturing. The reason is largely the same, namely, fairly cool and rainy summers in the north, long hot dry ones in the south.

So far as the form of the land is concerned Italy and Spain are quite different. The Iberian Peninsula, which includes both Spain and Portugal, is almost like a little continent with young high mountains on both north and south. In the north the huge Pyrenees, which separate France and Spain, are continued westward in the Cantabrian Mountains. On the south the equally lofty Sierra Nevada (11,400 feet at its highest) rises steeply from the coast east of Gibraltar. Between these two mountain ranges the peninsula consists of a high plateau from which rise many minor mountain ranges. The place where the plateau begins to break down toward the west has for centuries determined the location of the boundary between Spain and Portugal. In the center of the plateau, where the relatively flat parts spread out widely, we find Madrid, the capital. In two places broad valleys penetrate deeply into the plateau. There we find the only other inland cities of the first rank, namely Seville, far to the southwest among the vast olive groves of the valley of the Guadalquivir River, and Zaragoza in the northeast in the valley of the Ebro.

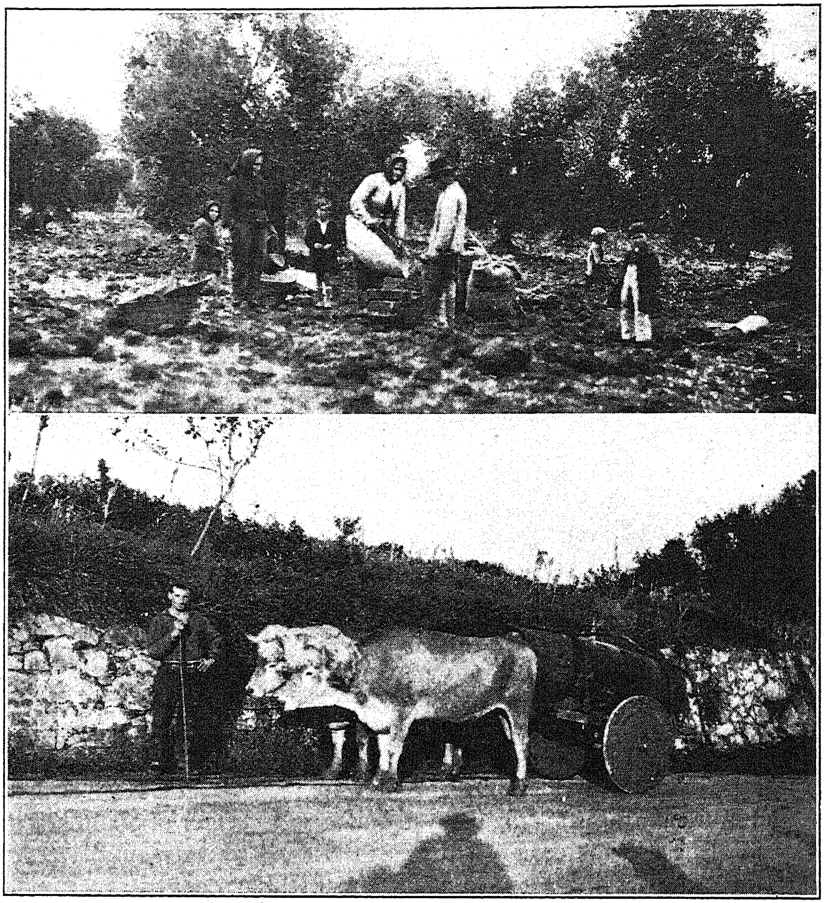
All the other large cities of Spain are seaports. Barcelona, the largest, located in the northeast, is the main manufacturing center of Spain. Next comes Valencia in the center of the east coast where the plateau recedes from the coast, leaving a fertile plain, famous for its oranges and other fruits. Malaga on the south coast occupies a similar but less favorable position. Its name is connected with grapes and raisins. Passing Gibraltar and going part way up the west coast, we come to Lisbon, the capital of Portugal, and then to Oporto, whence comes the name of a famous drink, port wine, made from a special kind of grape. Fruit and olives give fame to many Iberian cities.

Each of the eight cities that have just been mentioned can be picked out on the railroad map (A568). Madrid forms a little star; Valencia shows a cluster of railroads radiating out into its plain, but not in most

cases climbing to the plateau; from Oporto a railroad runs up the Douro River and sends many branches up tributaries of that river, but never climbs to the plateau. The Sierra Nevada, however, prevents Malaga from being a railroad center. The other cities, too, have their own

A

B



A-B—Farm Life in Spain.

A. A family gathering olives near Cordoba.
B. Oxen with pads of wool under a yoke tied to their horns, pulling a water cart with solid wooden wheels in Northern Spain.

pecularities. So does the railroad net as a whole. Note how scarce the railroads are throughout the entire Iberian Peninsula. They are scarcely more numerous than those of Russia, except that there are more hints of places where a dense network is beginning to develop. The mountainous character of the country is the main reason why Spain is so

different from France, for example, in this respect. The mountains work in two ways. In the first place, their slopes act directly to lessen the density of population and to make it difficult and costly to build railroads. In the second place they shut out rain-bearing winds, and thus make large sections so dry that few people can live there, especially in parts of the Ebro and the upper Douro valleys where irrigation is impracticable. In Spain and Portugal, far more than in most countries, the people live along the coasts, not only because that is where the land is level, but also because there the rainfall is greatest, especially on the north and west, or else the amount of water available for irrigation is greatest, which is especially important on the east and south. Irrigation is what makes Valencia and Malaga great cities.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Prepare three maps, all on as nearly the *same scale* as possible. Indicate the location of cities of more than 100,000 inhabitants in the following regions: (1) the horseshoe-shaped line of English cities surrounding the Pennine Chain of hills, together with the closely adjacent seaports; (2) the similar irregular line of German cities beginning with Aachen close to the southeast corner of the Netherlands, and extending as far as Bielfeld; (3) the American cities from Buffalo and Cleveland southward to Wheeling.

What resemblances or differences do you find in the three regions as to (*a*) number of large cities; (*b*) their total population; (*c*) degree to which they are crowded into a small area; (*d*) effect of (1) mineral resources, (2) soil and agricultural fertility, and (3) water routes on their development? Why do these three areas rank among the key regions of the world? Why does none of them include the largest city of its country?

2. In the railway map (A568) what evidence do you see of the effect of the following: (*a*) the Alps; (*b*) the Carpathians; (*c*) the Pyrenees; (*d*) other mountains in Scandinavia, Spain, the Balkans, the U.S.S.R.; (*e*) the Hungarian plain; (*f*) low temperature? How do you explain the scarcity of railways in northern Scotland, central Russia, eastern Spain, southern Yugoslavia, and Albania?

3. On an outline map of Europe insert all the European cities mentioned in this chapter, using three sizes of symbols according to population. Show seaports in black and interior cities in red. In what places do you find special groups of cities? What are the causes of such grouping?

4. What does your study of Europe indicate as to the relative importance of plains, minerals, climate, and seacoasts in determining the location of population, cities, and railways?

CHAPTER IX

COUNTRIES OF ASIA AND AFRICA

The Continent of Asia

Only about one fifth of Asia is of much use for human occupation, and close to half is almost useless. One reason for this is that much of Asia lies too far north for agriculture. Another is that Asia's vast size prevents oceanic influences from penetrating into large parts of the interior. Still more important is the fact that plateaus and mountains largely destroy the habitability of vast areas in the most favorable latitudes. Moreover, even the best parts of the mainland are less productive agriculturally, and less healthful and invigorating, than large sections of Europe and North America and small sections of South America and Australia. From the standpoint of size, Asia must be regarded as part of an enormous land mass which includes both Europe and Africa. This is broken by bodies of water such as the Mediterranean, Black, Caspian, and Red Seas, and the Persian Gulf, but these produce only a local effect upon the climate. Thus for practical purposes a mass of land about as wide as North America cuts off the best latitudes of Asia from the influence of the Atlantic Ocean. When one notes how much the climate of Europe is improved by winds and storms from the west, one realizes how greatly Asia is handicapped by its mere size.

One result of being so far from the sea is that in the latitudes which would otherwise be most favorable extremes of both heat and cold are great and the rainfall becomes highly seasonal. Except in a small section near Turkey the rain comes chiefly in the summer and early fall, and the winter and early spring are so dry that agriculture is handicapped.

Asiatic Plains

The location of the plains makes matters worse, as is clear from a study of the relief map. A large part of the main Asiatic lowland in Soviet Russia lies beyond the northern limit of profitable agriculture. Much of the rest is too dry because it is at least 2,000 miles from the Atlantic Ocean and is largely separated from the Indian Ocean by mountains. Aside from oases in this southern desert, the only extensive

part of the vast Soviet lowland that is even moderately good for agriculture is a narrow wedge from the southern Urals eastward along the Siberian Railway to Lake Baikal.

The other Asiatic lowlands are relatively small. Some, including Mesopotamia, eastern Arabia, and the Indus Valley, are of little use because, like all west coast or interior regions in latitudes 20° to 30°, they are deserts. This leaves the plains of the southeast and east as the only large lowlands where a really dense population can be supported. These include the Ganges Valley, a narrow strip on the east coast of India, central Burma, southern Siam, southern Indo-China, and the plain that extends from the Yang and Yellow Rivers (Yangtze and Hwang Ho) through Manchuria to the Amur River. Having abundant rain in summer, these plains are able to support about 42 per cent of the entire Asiatic population on about 3½ per cent of the area. Another 22 per cent of the Asiatics live on another 3 per cent of the land, consisting of hilly or mountainous country close to the well-watered southeastern plains, or on the neighboring islands of Ceylon, Java, the Philippines, Taiwan (Formosa), and Japan.

Asiatic Highlands and Western Loops

Turning now from the lowlands to the highlands, the main feature of the relief of Asia is a central mass of mountains and plateaus which begins in Asia Minor (Turkey) and widens eastward as far as Bering Strait in the northeast and the Malay Peninsula in the southeast. Much of this huge mass is divided into loops where mountains form a rim around plateaus or elevated basins. The first loop is Turkey, where mountain ranges near the north and south coasts enclose the high Anatolian Plateau. Toward the east the mountains unite in a sort of knot, the Armenian Plateau, higher than Anatolia. There Mt. Ararat rises 17,000 feet at the meeting place of Turkey, Persia, and Russia. From this knot the next loop opens out with the Elburz and Hindu Kush Mountains on the north near the border where Soviet Russia joins Iran (Persia) and Afghanistan, and with the South Persian and Baluchistan Mountains on the south. Between these the great Iranian Plateau or Basin includes most of Iran, Afghanistan, and Baluchistan. Its lowest part, Seistan, where these three countries meet, is occupied by swamps and large shallow lakes which come and go according to the rainfall.

Salt lakes, or saline plains where such lakes have dried up, occupy many other Asiatic depressions. An inland drainage, with rivers that wither away in the desert or end in salt lakes, is characteristic not only of Iran, but also of the Anatolian Plateau, and especially of the great basins farther east. Outside the main mountains, there are also some such basins with

salt lakes and no outlet to the sea, especially Balkash near the center of Asia, and the Sea of Aral and the Caspian Sea farther west.

At the eastern end of the Basin of Iran the mountains on the two sides converge into the Pamirs, a plateau some 13,000 feet above sealevel with mountains rising to almost twice that height (Muztag Ata, 24,400 feet). Here we find the meeting place of four countries instead of three as at Mt. Ararat and Seistan, namely Soviet Russia, Afghanistan, India, and Sinkiang, which used to be part of China. From the perpetual snow of the Pamirs great rivers flow northwestward across the sandy desert, watering oases and finally losing their diminished waters in the shallow brackish lake and vast reedy swamps of the Sea of Aral.

Asia's Inner Triangle

East of the Pamirs lies a vast triangle of plateaus and mountains. One side of the triangle runs roughly for 5,000 miles or more from the Pamirs to Bering Strait. Another, 2,500 miles long, follows the Himalayas to their eastern end, and then swings nearly southward to the inner end of the Malay Peninsula. The third side is formed by a line from this last point to Bering Strait. Inside this triangle an area more than twice the size of the United States is largely uninhabitable. It consists of great mountain ranges which more or less completely enclose basins and plateaus of all sizes. The basins are mostly deserts because the mountains shut out moisture from the oceans. The plateaus are generally too cold for agriculture because they are so high.

The most imposing feature of the triangle is the vast bulk of the Tibetan Plateau bounded on the south by the mighty Himalayas extending as far as from Winnipeg to New Orleans. The cold barren plateau between the Himalayas and two smaller but very lofty ranges farther north averages about 15,000 feet high and in places is quite flat even at a height of well toward 18,000 feet. North of Tibet a smaller loop, with the Tien Shan Plateau on its north side, encloses the desert basin of Tarim, or Lop, now known as the semi-independent region of Sinkiang. The basin seems low in comparison with the surrounding mountains, but it stands about 2,000 feet above the sea at Lop Nor, the lake to which the mountains drain. In glacial times Lop Nor was one of the world's largest lakes. The dry bed of the old lake consists of thousands of square miles of rock salt like thick cakes of ice tilted at all angles.

North of Lop Nor the small basin of Turfan actually falls to a level 425 feet below that of the sea. This makes it so hot in summer that, according to a Chinese legend, birds scorch their wings if they fly too high. A larger and deeper basin is occupied by Lake Baikal, one of the world's deepest lakes. Inasmuch as it is drained by the great Angara

River which joins the mightier Yenesei, its water is fresh. South of Lake Baikal the two regions known as Outer Mongolia (because it is far from China) and Inner Mongolia form another high mountain-girt plateau. This is bounded on the east for a thousand miles or more by the Khingan Mountains, which rise on the edge of a great escarpment bordering the plains of Manchukuo and North China. Farther north the eastern part of Siberia is a chaos of mountains. At the other (southern) end of the Khingan Range the Tibetan Plateau ends in a veritable fringe of ridges and gorges which cause parts of southwestern China still to remain unexplored.

Now we begin to see why most of Asia shows so few dots in the population map (A144) and is crossed by only one railroad from east to west and by none from north to south. If the relief of the continent were different—if it sloped gently upward to a high plateau in the north central part—millions of square miles which are now almost uninhabited because of dryness, ruggedness, or low temperature would be as productive as the plains of our west.

Asia's Eastern and Southern Fringe

The eastern part of Asia consists of the plains already mentioned and of isolated mountain masses. Look again at the map and note the three distinct forms taken by these mountains. (1) The first form is isolated ranges more or less parallel to the coast, as in southeastern Siberia between the lower Amur River and Vladivostok, China south of the Yangtze, and Annam in the eastern part of French Indo-China.

(2) Other mountains take the form of rough peninsulas such as (*a*) Kamchatka in the far north, (*b*) Korea or Chosen, (*c*) the small but populous peninsula of Shantung in North China, and (*d*) the narrow but rugged Malay Peninsula. The triangular southward projection of India (*e*) is another such peninsula. Just as Shantung is separated from the mountains farther west by an alluvial plain laid down by the Yellow River (Hwang Ho), so the Indian Peninsula is separated from the Himalayas by the Indo-Gangetic Plain composed of alluvial deposits laid down by the Indus and Ganges. Farther west the Arabian Peninsula (*f*), as large as the United States east of the Mississippi River, is similarly separated from the central mountains of Asia by the alluvial plain of the Tigris and Euphrates in the modern country of Iraq. The Indian and Arabian peninsulas are also alike in being high on the west, especially in the south, and sloping eastward.

(3) Islands are the third form taken by the mountains that fringe Asia on the east. Because this coast has been depressed, partially enclosed seas take the place of the plains and basins farther inland. Thus in

the north the mountains of the Kamchatka Peninsula continue southward through the little Kurile Islands to Hokkaido, the northern island of Japan, and the Sea of Okhotsk is thus enclosed. Next the islands of Hokkaido and Honshu, the main island of Japan, enclose the Sea of Japan. Then comes the Yellow Sea, named from the mud brought into it by the Yellow River, and lying west of the Chosen Peninsula. Farther south the great South China Sea is surrounded by partly drowned mountain ranges which rise to high levels in the Philippines, Borneo, and Sumatra. The two latter islands, together with Java and Celebes, surround the Java Sea. If Asia stood a few thousand feet higher all these islands would be seen as parts of high mountain chains surrounding basins and plateaus like those of the great triangle of inner Asia.

Countries of Southwestern Asia

Turkey

The next step in our study of Asia is to become familiar with the various countries and their cities. On a small scale Turkey repeats many features of Asia as a whole. The most habitable part consists of small alluvial plains close to the coast. One set of these, in river valleys near the west coast, formed the old Greek region of Ionia. After living there 2,500 years or more, the Greeks were finally taken to Greece after the first World War. Izmir (Smyrna), the only city in Asiatic Turkey that approaches 200,000 in population, lies at the mouth of such a valley. Another set of plains consists of alluvial deltas formed by mountain rivers on the north and south coasts. The largest of these is at Adana near the northeast corner of the Mediterranean Sea. Wherever the slopes face the sea there is a fair annual rainfall, although everywhere the summers are dry, as befits the Mediterranean type of climate. Inside the mountain barriers, however, the rainfall becomes scanty, grass instead of trees usually covers the slopes, and irrigation is needed for crops other than those such as winter wheat, which are planted in the fall and reaped in the spring. Crop failures are frequent, and the yield per acre averages low. Railroads are naturally scarce (A569). A few run inland along the western valleys. A main railroad connects Istanbul with Adana and Syria, and another runs through Ankara, the new capital, to the Armenian Plateau and Soviet Russia. Many railroads have been built recently.

Syria and Palestine

Geographically, although not politically, Syria and Palestine belong together. The most habitable part consists mainly of two north and south mountain ranges, or plateaus, with a long, narrow depression, or rift

valley, between them. East of these the land slopes gently away and is desert because it lies in the rainshadow of the mountains. Curiously enough two of the three largest cities lie east of the mountains on the edge of the desert. In both cases this is due to irrigation by streams from the mountains. Aleppo depends on rivers from the Armenian Plateau to the north. Damascus, farther south, is separated from the sea by two lofty mountain ranges. One of these, Mt. Lebanon, close to the coast, is famous for its huge cedars, much like our giant sequoia trees in California, which grow in a similar climate. The Anti-Lebanon or Mt. Hermon Range lies farther east. Water which falls on its west side flows through the mountains to the east side in a deep gorge. Thus the desert city of Damascus has been able to become larger than its seaport, Beirut, just as Aleppo exceeds its seaport, Alexandretta.

Farther south in Palestine the mountains take the form of flat-topped plateaus on both sides of a deep rift valley, where a long, narrow section of the earth's crust has dropped down in the same fashion as the Rhine Graben. In this lie the Sea of Galilee, the Jordan River, and the Dead Sea, the last being 1,300 feet below the level of the Mediterranean. Jerusalem is located on the top of the western plateau. It, too, has its seaport, Jaffa. The actual seaport is much smaller than Jerusalem, but the presence of the narrow Philistine plain between the sea and the Judean plateau, where Jerusalem is located, enables this area to support another large city in addition to Aleppo and Damascus. In this coastal plain a considerable flow of underground water permits extensive irrigation. This has made it possible for the Jewish industrial city of Tel Aviv to grow up close to Jaffa. The two together form the largest city in Asiatic Turkey, Syria, Palestine, or Arabia.

Arabia and Iraq

From Syria a railroad heads toward the new country of Iraq, which consists mainly of what used to be known as Mesopotamia, the land between the Euphrates and Tigris rivers. Iraq depends upon river water for irrigation almost as completely as does Egypt. It has one other great resource, namely, oil. Pipe lines carry the oil to the seacoast in Palestine and Syria, thus diminishing the importance of the long-planned railroad from Aleppo to Baghdad, the chief city of Iraq. Aside from oil there is little freight in this dry region, and passengers usually cross the desert in motor cars. In large portions of the desert, especially the gravelly parts, one can drive almost anywhere without making roads. Bus lines run regularly from Damascus to Baghdad, with no road much of the way.

From Palestine a second desert railway heads southward. It was built by the Turkish government at the beginning of the nineteenth century

to carry pilgrims to Mecca, far south in western Arabia. It was never completed beyond Medina, which ranks next to Mecca as a holy city among Mohammedans. Since the first World War all but the northern part has been given up. A desert such as Arabia cannot produce much that enters into commerce, so the railroad did not pay.

Beginning on the west, Arabia consists of (1) a narrow coastal plain along the east side of the Red Sea; (2) a deeply eroded escarpment where rugged valleys lead rapidly upward; and (3) a high plateau with many old volcanoes along its crest and with a gentle slope eastward to the Persian Gulf. The main oases, such as Medina and Mecca, lie near the escarpment where the rare streams flow out of the mountains. In addition to this there are some oases in the interior where occasional highlands supply a little extra rain. Yemen in the southeast is the highest part of Arabia, aside from a small area in Oman, the eastward projection of the peninsula. In Arabia Felix (Fortunate Arabia), as the Romans called Yemen, there is rain enough to support a settled population. Elsewhere the people either live in oases where water from the higher mountains is available, or are Beduins who wander with their camels, sheep, and goats. In the days of King Solomon, three thousand years ago when there was apparently more rain, the Queen of Sheba probably lived in one of the cities whose great ruins are still seen high among the mountains in Yemen. Curiously enough another of the most famous queens of all history, Zenobia, the Arab, also lived in a magnificent city which is now almost waterless. Her home of Palmyra, in the Syrian Desert, is now one of the world's most superb ruins.

The Basin Plateau of Iran

On the whole, Persia, now officially called Iran, is one of the poorest of countries; Afghanistan is not much better; and Baluchistan is worse. The trouble is lack of water. Mountains, as we have seen, hem in these countries on all sides. The mountains supply water for irrigation, and thus the oases are fairly fertile and quite pleasant, but they contain too many people in comparison with the amount of land that can be irrigated. On the higher land among the mountains winter wheat and similar crops are raised without irrigation, but the yield per acre is small and the crops are often deficient. Vast areas, however, are given over to deserts of gravel, bare rock, sand, and vast flat expanses where salt lakes have stood in the past.

The presence of a city in the Iranian Basin, or in any other arid country, is an almost certain indication of mountains which supply water. The rain and snow of the lofty volcano of Demavent (17,930 feet) and of the neighboring parts of the Elburz Mountains have made it possible

for Tehran to become a large and in many ways quite modern city. Tabriz in northwestern Iran, the only other Iranian city of more than 200,000, has its own lofty mountains and is helped by the snows of Mount Ararat. These water the plains north of Lake Urmiah and thus help to provide a well-peopled "hinterland," or tributary region, such as is necessary if a city is to grow great. High among the eastern mountains of the Basin of Iran, the largest cities of Afghanistan (Kabul with 80,000 people) and of Baluchistan (Quetta with 50,000) have a similar relationship to mountains. Sometimes the mountains are far from the people whom they support. The lofty Hindu Kush Range of northeastern Afghanistan supports not only Kabul and hundreds of smaller places near the mountains, but also the strange oasis of Seistan at the end of the Helmand River. There the river, after irrigating the fields, spreads out in floods and forms hundreds of square miles of swamps filled with enormous reeds. The swamps are the home of the strange Fowlers who get much of their living by snaring waterfowl in the little lanes of water among the reeds.

Practically everywhere in the dry sunny basin of Iran, just as in Turkey, Syria, Palestine, and Arabia, wood is so scarce and the climate so dry that the houses are made of dried mud (adobe). Generally they have flat roofs supported by wooden beams, but where wood is especially scarce the roofs are often domed.

Thanks largely to British enterprise a railroad has been constructed from the Persian Gulf to Tehran, but until after 1930 Persia was practically without railroads, as Afghanistan still is. A railroad in Baluchistan runs occasional trains to Seistan, but does not pay. It was built because the British wanted to reach Persia easily and forestall the Russians in gaining influence there. Neither cities nor railroads thrive in the great central deserts of the Iran Basin, but the surrounding mountains and plateaus, especially in the northwest and northeast, are quite habitable.

India

The Northern Mountains. One of the most impressive features of India is the extreme contrasts. The huge Himalaya Mountains on the north, for example, are vastly different from the great Indo-Gangetic Plain at their base. The Himalayas are the most rugged region on the earth's surface. Nowhere else do mountains rise so high, or slope up more rapidly from near sealevel. Valleys a mile deep are so common that one scarcely notices them. Some are 10,000 feet deep, and a few approach 15,000. The deepest valleys take the form of vast canyons at the two ends of the Himalayas. That range, it will be remembered, forms a rim along the edge of the Tibetan Plateau which lies 15,000 feet more or less above the sea. From sources close together just back of this rim at a height of

18,000 feet or more, the Indus and Brahmaputra rivers flow away from each other until they are 1,500 miles apart. Then they turn south through the mountains in canyons so deep that no one can follow the lower part of either. The Sutlej branch of the Indus also breaks through the Himalayas in a similar canyon. Various other branches of both the Indus and the Brahmaputra and all the main headwaters of the Ganges pour down the southern face of the Himalayas in vast torrents. They have gullied into the mountains so vigorously that the Himalayas and the front of the Tibetan Plateau are carved into a vast fringe, a perfect chaos of mountains.

The Himalayas and the high mountains that run southward from them at each end protect India from cold northern winds and prevent the moisture of the Indian Ocean from passing to the north. Thus the mountains make India warmer and more tropical than it would otherwise be.

Another effect of the mountains is to foster independence among the inhabitants of their lower slopes. Hence Bhutan and Nepal are independent states not subject to British rule. Aside from little Sikkim, where Darjeeling is located, they occupy the whole of the eastern Himalayas. At the western end, too, Kashmir, although ruled by Great Britain, is one of the most independent parts of British India.

The Indo-Gangetic Plain. Descending now to the lowlands, we find that for 1,500 miles in a great arc from the lower Brahmaputra and Ganges to the lower Indus, the Indo-Gangetic Plain is so flat that the horizon is almost like that of the sea. For hundreds of miles the alluvial soil deposited by the rivers is so fine that one can scarcely find a pebble. Climatically, however, this great plain is far from being uniform. During part of the year its eastern end is drenched in rain. The southward-facing slopes that rise above it receive some of the world's heaviest rainfalls. At Cherrapunji, 275 miles northeast of Calcutta, the summer wind known as the southwest monsoon brings an average of about 100 inches of rain in July. The average for the year as a whole is 428 inches. Even at Cherrapunji, however, the four months from November to February get scarcely enough rain to keep the ground wet, and elsewhere there is far less. The wet and the dry seasons are amazingly different not only here, but in most of India.

As we go down the lower Brahmaputra and then up the Ganges and down the Indus another great contrast comes into view. The railroad map illustrates it. The eastern end of the plain close to the mountains is so wet that its people are considerably handicapped. A rainfall of 15 to 20 inches each month for two or three months is by no means easy to cope with. Hence, while there are many villages, we find no large city and

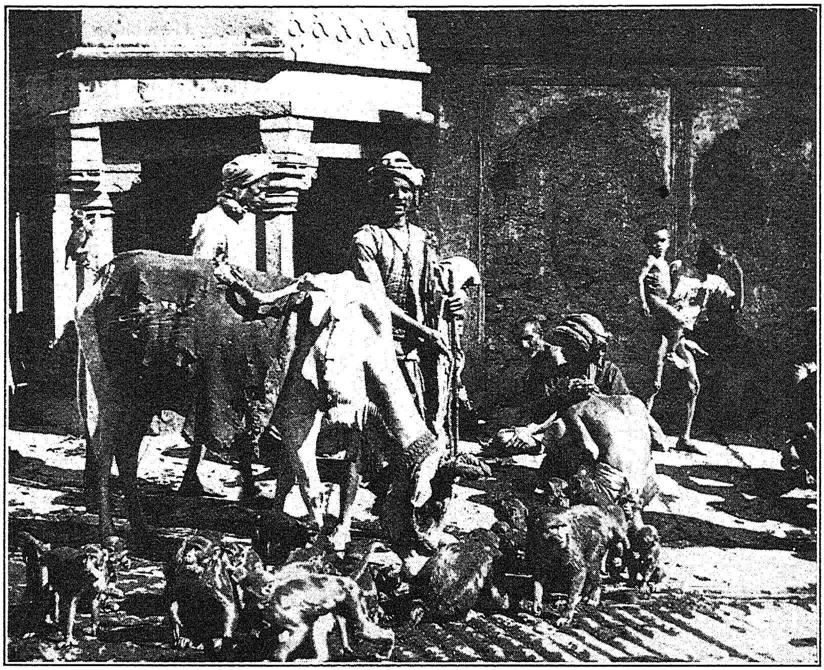
few railroads until we approach the mouth of the combined Brahmaputra and Ganges. There, where the total annual rainfall is toward 60 inches, and where June, July, and August each have about 12, we find Calcutta, the largest city and former capital of India, with a population of a million and a half. It is the seaport and trading center not only for the province of Bengal, which contains over 50 million people (far more than in France, Italy, or Great Britain), but for another hundred million or more, farther inland.

Toward the northwest, up the flat Ganges Valley with its fine-grained fertile plain of alluvial silt, the population continues to be dense. At first, in the provinces of Bengal and Bihar, the people are mainly rice raisers, but gradually, as we get into the United Provinces (50,000,000 people) and then into the Punjab or Five River Province (25,000,000), wheat becomes the dominant crop. So abundant are the people, over 500 per square mile and sometimes 1,000, that great cities become numerous and the railroads form a genuine network. To find the first city with more than 200,000 inhabitants we have to go up the Ganges some 300 miles. Then in the next 400 miles or so we find no less than six: first the sacred city of Benares, where pilgrims bathe their dead and themselves in the water that they drink; then Allahabad; Lucknow; Cawnpore, famous for its harness factories and a massacre of British women and children in 1857; Agra, with the Taj Mahal, the most beautiful and stately tomb ever made; and finally Delhi, the capital of all India. By this time we have reached a climate which is delightful in winter, averaging 58° in January, but frightfully hot in June (92°). We have also reached a climate so dry that irrigation is essential. At Delhi only the four months June to September average 3 inches or more of rain (8 in July). All the rest have less than 1 inch, so that here, too, the contrast between the wet and dry seasons is strong.

Northwest of Delhi the increasing dryness causes the population to become less dense in spite of irrigation. Hence we have to travel nearly 300 miles before finding another city with 200,000 people. We find two, Lahore and Amritsar. One of the most impressive things in this region is enormous irrigation works built by the government to use the water that pours down from the Himalayas. Still more impressive in another way are the hundreds of thousands of shallow wells from which the peasants laboriously lift water to irrigate their tiny fields. Everywhere vast labor is expended for a very small return. Among all the great countries India probably has the lowest standards of living.

Now we turn south down the Indus and find no more great cities and only a few railroads until we reach the port of Karachi at the mouth of the Indus, more than 600 miles from Lahore. The population becomes

so scanty that we can sometimes travel miles without seeing a soul. The reason is that the rainfall declines and the heat and evaporation increase until Jacobabad is reached. That little irrigated city, at the foot of the Baluchistan Mountains half way from Lahore to Karachi, lies in a desert where the total rainfall for the whole year averages only 4 inches. The dryness is intensified by the fact that, although Jacobabad is 28° from the equator, it experiences about the hottest weather known in any part



Keystone View Co.

A—Some Causes of Poverty in India.

This cow gives no milk, but because cattle are sacred among the Hindus it is allowed to eat anything it chooses, even the vegetables that the poor peasants are selling in the market place. The monkeys, too, are allowed to snatch food needed by the people.

of the earth. In June the average temperature for day and night together is 98°. Day after day a maximum of 120° to 127° may be reached.

The Indian Peninsula. The eastward-sloping plateau of the peninsula forms a third great section of India in addition to the northern mountains and the Indo-Gangetic Plain. On the west side the mountains known as the Western Ghats rise steeply from the Arabian Sea and form a ridge along the edge of the plateau. As the east coast is approached, the plateau rises again in low and irregular mountains known as the Eastern Ghats.

In the peninsula, just as in other parts of India, the alternating monsoon winds, blowing equatorward in winter and more or less northward in summer, usually give a strong contrast between a dry winter and a wet summer. The mountains cause the coasts to be better watered than the interior. Hence the population is densest along both coasts, although rarely as dense as in the plain of the Ganges. The west coast, however, rises too steeply from the ocean to have a railroad.

Great cities are not numerous in the Indian Peninsula. In the west, Ahmadabad, a little way back from the coast near the Tropic of Cancer, is connected by a coastal railroad with Bombay, the second city and greatest seaport of India. On the eastern side of the peninsula, Madras, the third city in size, is the main port and only really large city south of Calcutta. The fertile lowland of Madras is the only place where the railroads of South India suggest a close net. In the drier interior of the plateau, irrigation from artificial ponds is practiced assiduously. Several kinds of drought-resistant millet are the chief crops. Although they are poor food, they support many people. Cotton, grown especially in the rich black soil of the Deccan Plateau in the northwestern part of the peninsula, helps in providing a living. Therefore half way across the northern part of the peninsula we find the large city of Nagpur, while southeast of Bombay we come first to the cotton-manufacturing city of Poona, and then to the great native capital of Hyderabad.

In the southern tip of the Indian Peninsula the rainy season is longer than further north and the people suffer less from drought and crop failure. Therefore cities are relatively numerous. In the latitude of Madras the city of Bangalore has lately grown amazingly as a manufacturing center. Farther south, and only 10° from the equator, Madura has long been famous for its huge ancient temples, barbaric though beautiful.

Ceylon. The island of Ceylon is part of India. It is connected with the mainland by Adam's Bridge, a series of sand banks some 30 miles long, on which the water is nowhere more than 3 or 4 feet deep at high tide. So much does the sand shift that a prolonged attempt to maintain a ship channel has been abandoned. Adam's Bridge leads to a rather sparsely populated lowland in the north of Ceylon and to a densely populated mountain region in the south. Here, as in similar latitudes everywhere, the rainy windward side of the mountains at an elevation of 3,000 to perhaps 7,000 feet is a fertile, pleasant region. The temperature is low enough to get rid of the most enervating feature of a tropical climate, and the rain is sufficient to support plantation crops such as tea and coffee. So in Ceylon, more than in other parts of India, there is a great development of tropical plantations, run by white men but with native

laborers. The famous tea of Ceylon is shipped from the one important port, Colombo, where a great many ships call on their way between Europe and the Far East or Australia.

Southeastern Asia

The Rice Plains

In a certain way southeastern Asia, including Burma, Thailand (Siam), French Indo-China, and the Malay Peninsula, repeats the main features of India. It has high mountains to the north, then some level, densely populated alluvial plains, and finally a high peninsula. The northern mountains, however, trend north and south instead of east and west, the alluvial plain is broken into many parts, and the peninsula is relatively small. Although most Americans know little about this region, its area is as great as that of the twenty of our states lying east of the Mississippi, omitting New York and New Jersey. Although most of the area is mountainous, its population (well toward 60,000,000) is about the same as that of these same twenty states. This means that the plains, which constitute only a small part of the area, are densely populated. The reason for the density is that southeastern Asia rivals Bengal, Java, southern China, and Japan as the world's greatest rice-raising region. Nowhere is more rice raised in proportion to the population than in Thailand. That little country raises about 700 pounds for every one of its men, women, and children. Except for the rubber of Malaya, however, neither Thailand nor any of the other countries of southeastern Asia raises much beside rice. Therefore, although the people are quite well fed, they have little to sell to other nations, and can buy little in return.

A Bunch of Rivers

One of the main characteristics of southeastern Asia is that it comprises a remarkable group of almost parallel rivers which rise among the world's loftiest mountains, run southward through tremendous gorges, and end in the broad, fertile alluvial plains and deltas where the rice is raised. On a relief map note the great rivers which traverse the 250-mile stretch between the eastward bend of the Brahmaputra River and the nearest point of the great Yangtze of China. In this space, or just south of it, we find the main stream, or at least the headwaters of (1) the Brahmaputra itself, (2) at least eight great rivers beginning with the Brahmaputra on the west and ending with the Yangtze on the east. They are like a bunch of strings of various lengths, all gathered together at one point, but spread out widely below that point, while the longer ones spread out less widely above.

If anyone wants a hard journey, let him try to follow the northern border of French Indo-China, Siam, and Burma. For every hour that such a trip would take in an airplane, it will take at least a month on the earth's surface. Even then it will be necessary to depart considerably from the boundary line in order to find places where even the hardy mountaineers of this region can travel on foot without animals. A still harder trip would be to start in China at the southward bend of the Yangtze not far north of the city of Yunnan and travel straight to Lhassa, the small capital of Tibet. The simple little lines which indicate rivers on the map become vast canyons 5,000 to 10,000 feet deep when one attempts to cross them. In their lower depths the canyons are hot, steamy, enervating, and hard to traverse because they are so densely forested and malarial. Their slopes are so steep that they can be climbed only in a few places. The tops of the ridges are so cold, windy, and even snowy that people who come from the hot valleys shiver in their warmest clothes. Small wonder, then, that villages are scarce in the northern parts of Burma, Thailand, and French Indo-China. The rugged relief isolates the people so much that they are backward and often highly suspicious of strangers. In all the world it is hard to find any equally large region where mountains alone, regardless of climate, make it so hard to get a living and to carry on commerce as in the northern parts of these countries and the adjacent provinces of China.

Countries and Cities of the Plains

The contrast between all this ruggedness and the level rice plains at the lower ends of the rivers is almost incredible unless one has seen it. The plains look small on the maps that we usually see. They are so broad that when one looks out from some high point, such as a Burmese pagoda, or the deck of a steamer sailing on one of the quiet distributaries in the delta of Thailand or Cochin China, the horizon forms a perfect circle. It bounds a plain almost as smooth as the sea, bright green with rice close at hand and becoming more and more bluish farther away. Each main delta has its port, Rangoon at the mouth of the Irrawaddy in Burma, Bangkok on the Menam in Thailand, and Saigon near the mouth of the Mekong in French Indo-China. Here, as in most tropical countries, the inland cities are small and inconspicuous. Mandalay on the Irrawaddy is the most famous. It gets only one third as much rain as Rangoon, where 100 inches fall each year on an average.

Burma was governed from India until 1937. Then the British government decided to make it a separate political division in recognition of the fact that it is separated from India by high mountains, and also differs from that country in the race, religion, and language of its broad-faced,

Mongoloid, Buddhist people. Siam, to use the old name, is unique as a tropical country of the Old World which has remained independent. In Indo-China the French try to make the cities as much like Paris as possible, but leave the natives to their old customs elsewhere.

One of the most remarkable features of southeastern Asia is the great ruins in Cambodia. There, in the neighborhood of Ankhor Wat, ruins of great temples and other edifices made by a numerous and highly skillful people are scattered through an almost uninhabited jungle. No one fully understands the circumstances under which these buildings were constructed, or the causes which led to their abandonment.

The Malay Peninsula

The slender, rugged Malay Peninsula is quite different from the rest of southeastern Asia. It is politically divided into a northern portion belonging to Thailand, and three British portions known as the Straits Settlements, the Federated Malay States, and the Unfederated Malay States. Its rough mountains, like those farther north, are inhabited by wild and uncivilized tribes, especially on the wet east side. Another outstanding feature is that in addition to the native Malays the peninsula contains numerous Chinese who form the bulk of the city population. This is due to the presence of tin mines, rubber plantations, and a great trade route which goes through the Strait of Malacca between the Malay Peninsula and the island of Sumatra. In the mines and on the plantations the Chinese make better laborers than either the Malays or people brought from India. The presence of the Strait has caused the great seaport of Singapore to grow up on a little island at the very tip of the peninsula, and Chinese workers are needed there, too. Singapore and Penang, on a similar island farther north, form the Straits Settlements.

The East Indies

Many people fail to realize the great size of the East Indies, or the magnitude of the contrasts among them as to density of population. Both these conditions are evident in the following table, where the ten largest islands of the East Indies are compared with European countries and parts of the United States as to area, population, and persons per square mile.

New Guinea is as large as France and Italy combined, or as the eight states from New York and New Jersey to Illinois and Wisconsin. Its population of untutored, almost unclothed savages, however, would have to increase 50-fold to rival that of France and Italy. The next island, Borneo, is about the size of Turkey or Texas, but has only a fifth as many inhabitants as Turkey and half as many as Texas. Sumatra, which is a

THE LARGER EAST INDIES COMPARED WITH PARTS OF EUROPE AND THE UNITED STATES

	Area, 1,000 Sq. Mi.	Population Thousands	Population Per Sq. Mi.		Area, 1,000 Sq. Mi.	Population Thousands	Population Per Sq. Mi.		Area, 1,000 Sq. Mi.	Population Thousands	Population Per Sq. Mi.
New Guinea	332	1,500	5	France and Italy	333	85,000	255	Middle Atlantic and East North Central	355	54,000	152
Borneo	292	3,000	10	Turkey	282	16,500	59	Texas	262	6,400	24
Sumatra	153	6,000	39	Finland	150	3,700	25	California	156	6,500	42
Philippines*	114	13,500	118	Rumania	114	19,500	171	Arizona	114	450	4
Celebes	73	4,500	62	Uruguay	72	2,200	31	North Dakota	70	700	10
Java	51	43,000	842	England	51	41,000	805	Alabama	51	2,800	55
Formosa (Taiwan)	14	5,400	386	Netherlands	13	8,600	660	New Hampshire and Vermont	18	850	47
Timor	12	800	67	Belgium	12	8,600	716	Mass. and Conn.	13	6,200	477
Flores	9	450	50	Palestine	9	1,400	156	Vermont	9	360	40
Serang (Ceram)	6.6	80	11	Hawaii	6.4	400	63	New Jersey	7.5	4,200	560
Halmahera	6.5	100	14	N. Ireland	5.6	1,300	232	Puerto Rico, R. I., and Delaware	6.5	2,650	408

*A group of islands.

great rubber island, equals Finland or California in size, and has about the same population as California. The Philippines, which include 7,083 islands or islets, 466 of which are more than a square mile in extent, are as large as the entire country of Rumania or the state of Arizona. They have quite a dense population, nearly 25 times as dense as New Guinea, but only two thirds as dense as Rumania. Celebes, which on most maps looks like a sprawling spider east of Borneo, proves to be as large as Uruguay, or North Dakota, and has decidedly more people than either of them, although the density per square mile is only like that of Turkey.

The next island in size is Java. Here we find a most astonishing condition, namely, a size like that of England, or Alabama, and a density of population like that of England and about 15 times as great as in Alabama. In the table the Japanese island of Taiwan (Formosa) appears to be the only other island that approaches Java in density of population. If Luzon, the northern island of the Philippines, is taken alone, however, it too falls among the highly populous islands.

Four smaller islands are mentioned in the table. Most people have never heard of them, although their size equals that of famous regions such as Belgium, Palestine, Hawaii, or Northern Ireland. Even the smallest is as large as Puerto Rico, Rhode Island, and Delaware combined. Its population, however, would have to be multiplied by 35 in order to be as dense as that of Puerto Rico (close to 500 per square mile).

One of the features of the East Indies that most needs to be explained is why Java has more people per square mile than England, Belgium, New Jersey, or even Puerto Rico, whereas New Guinea, in essentially the same latitude, has less than any other place in the preceding table except the mountainous and arid state of Arizona. The answer is not found in the relief of the earth's surface. All the East Indies are mountainous, but New Guinea, Borneo, and Sumatra, with 5 to 39 persons per square mile, have relatively larger lowlands than has Java. Nor is the answer found in industrial development and cities. Java, to be sure, lays claim to the only two large cities in the East Indies, namely, Batavia near the west end of the island, and Surabaya near the drier east end. Moreover, some towns on the Javanese highlands, such as Bandung, give promise of becoming large cities. Nevertheless, if all the cities were removed from Java, the population would still be as dense as that of England in which the huge cities of London, Liverpool, Manchester, and Birmingham are included. Nor can the answer be found in methods of government, for the Dutch govern scantily populated areas in New Guinea and Borneo, and the moderately populated islands of Sumatra and Celebes, as well as Java. The British govern the rest of Borneo and New Guinea as well as densely populated Ceylon. In the Philippines, for which the Ameri-

cans have been responsible since 1898, the island of Luzon is densely populated in its western part, whereas eastern Mindanao farther south is much like New Guinea.

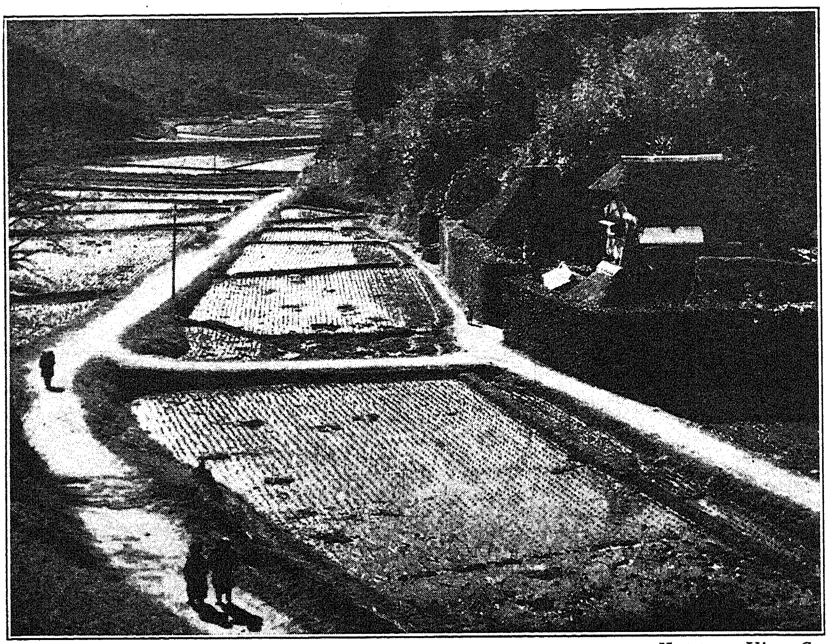
One reason for the increasing sparseness of the population as we go from Java to the northern Philippines, Celebes, Sumatra, Borneo, and finally New Guinea, may be the character and culture of the people. Far more important reasons, however, seem to be the soil and the rainfall. Java supports an almost incredibly dense agricultural population mainly because of two conditions. First, its soil is constantly being renewed and enriched by volcanic eruptions which provide material that is washed down the mountainsides to the terraced rice fields and the alluvial plains. Second, a good share of the island has abundant rain part of the year, but also a reasonably but not extremely dry season for several months. The other East Indies have progressively lower densities of population and lower stages of culture as these two conditions disappear. New Guinea, for example, has relatively little young volcanic soil, and few well-drained, fresh alluvial plains. Where it has such soil, it rarely has the right amount and seasonal distribution of rainfall. Either there is too much rain and no sufficiently long dry season, or else there is not enough rain and the dry season is too long. Tropical countries are especially sensitive to variations in the quality of the soil and in the seasonal distribution of rain.

China

Influence of Plains and Warm, Rainy Summers. The outstanding geographical problem of China, as of India, is how so vast a population can be supported on so small an area. In both countries non-geographical or human factors, such as old customs and the willingness or ability of the people to exist on a low standard of living, enter into the matter. This, however, is equally true in many regions where the population is sparse, instead of dense, for example, in the deserts of Persia and Baluchistan. The human factors lead to a dense population only when combined with certain distinct conditions of geographical environment. One of these conditions is broad, level plains composed of fine-grained alluvial deposits which are frequently renewed by rivers.

Such plains alone do not lead to a dense population, as is evident from the scarcity of people in the dry Indus Valley. They become effective mainly when combined with warm, rainy summers. Where abundant summer rains prevail and the harm done by a dry season, such as occurs in China and India, is mitigated by cool winters or by irrigation, a dense population is usually found not only in plains, but also among hills and mountains. We have already seen how this works in the Indian

peninsula where irrigation from "tanks" or ponds is widespread. In China, too, although tanks are not common, there is a vast amount of irrigation from mountain streams and by raising water by hand from the rivers in the plains. Because of this, among the mountains of China south of the Yangtze and west of the northern plains, the lower slopes are almost everywhere painstakingly terraced—often to a truly astonishing degree. Back of Fuchow on the southeast coast, for example, scarcely half the people are supported on the small fraction of the land lying in



Keystone View Co.

A—An Irrigated Rice-raising Valley in South China.

Note (1) the narrow road which is unusually wide for China, (2) the steep sides in contrast to the flat floor of the valley, (3) the thatched house surrounded by a thick hedge and placed just beyond the limit of the easily watered valley floor.

the valley bottoms. The rest raise rice, sweet potatoes, tea, and other crops on terraced hillsides which are often quite steep.

South China. A bird's-eye view of China, beginning in the far southwest, shows first the high plateau of Yunnan. There a large city of the same name is cool and comfortable because it lies so high. It is connected by rail with Hanoi and the port of Haiphong in French Indo-China, a fact which greatly helped the Chinese in their war against Japan. East of Yunnan an irregular mass of well-populated mountains is broken by

the valley of the Si, or West River. This river looks small on the maps which we commonly use, but is really something like our Ohio in size. Near its mouth, but not on the main river, we find two of China's main cities, Canton on the mainland, and Victoria on the island of Hongkong, owned by Great Britain.

Now let your eye sweep 500 or 600 miles up the coast of China, looking at the beautiful bays and islands that fringe the mountainous coast. Here we find two more of China's largest seaports, Amoy and Fuchow. Farther inland the country is so mountainous that in spite of a dense and industrious population no railroad traverses it until we reach the inland line from Canton northward. That line leaves the mountains and comes out onto a branch of the Yangtze plain of central China, not far from two other great cities, Changsha and Siangtan.

Central China. In order to see what central China is like, let us go back to the coast. Near latitude 30° N, where China juts farthest east, we find a remarkable group of great cities and one of the most prosperous parts of China. Where the mountains come to an end a deep bay with hundreds of lovely little islands is surrounded by large cities. Ningpo lies on the south side, beautiful Hangchow spreads itself among wooded hills and pagodas near the inner end of the bay, and Shanghai, one of the world's greatest cities, a little farther north near the mouth of the Yangtze, receives ships from all lands.

At Shanghai we are on the great alluvial plain which forms the most populous part of China. Curiously enough, although a railroad runs westward from the coast at Hangchow to Changsha, none does so from Shanghai. The need of such a road is not urgent at Shanghai because the Yangtze furnishes a waterway open to oceangoing ships. Instead of taking a river boat, however, we can take the Peiping railway northwestward from Shanghai across the plain through Soochow to Nanking, the capital. There we transfer to a river steamer and go up the Yangtze to the smoky, drab, industrial center of Hankow where we meet the north and south railroad from Canton and Changsha. Continuing onward by river boat we go up the famous rapids at Ichang, and pass through the mountains to Szechwan, the Red Basin. It is amazing to find 53,000,000 people—as many as in all Central and South America aside from Brazil—tucked away in this great fertile hollow behind high mountains near the borders of Tibet. It is still more surprising to find that, although they are poor according to our standards, they are among the most prosperous of the Chinese. They do enough business to support two major cities, Chunking on the Yangtze, and Chengtu on a branch well up toward the Tibetan Plateau. Much of their prosperity is due to the lofty mountains around them which provide abundant water for irrigation.

North China. Now we must go back down the river and at either Hankow or Nanking take the train for Peiping. From Nanking we travel north across one of the world's flattest plains for hundreds of miles. In a part of the plain laid down by the many branches of the Hwai River we cross the main railway line from the coast south of Shantung to the southward bend of the upper Yellow River and the great inland city of Sianfu. When our train reaches the lower part of the Hwang Ho we literally find the river flowing on top of an embankment. This, together with the extreme flatness of the Hwai plain, makes us realize how easy it is for excessive rains not only to waterlog the fields (because the water will not run off), but to cause the rivers to break their bounds and flood thousands of square miles of the plain.

East of this part of the railroad lies the peninsula of Shantung with its bare treeless mountains and swarming people. Here again we find a group of great cities—Tsinan where the railroad crosses the Hwang Ho (Yellow River) and Kiaochow and Tsingtao close together on the south side of the peninsula. In Shantung the scarcity of trees brings home another important factor which joins with the floods to make life much more difficult in North China than in the center or south. Trees are scarce partly because the population is so dense and the winters so cold that everything that will burn is eagerly sought, including even grass. Even if there were no people, however, forests would have a hard time because of the dryness of the winter and spring. Sometimes the rain holds off so long in the spring that crops cannot be planted on unirrigated land in time to ripen before frost comes in the fall. Thus famines arise both from floods and from droughts. The dangers from both kinds of disaster continue as we go on to Tientsin, the most northerly great port of China Proper. At Peiping, not far away at the foot of the Khingan escarpment, floods are not a menace, but drought often brings distress.

If we cross the Khingan Mountains on the railroad that runs to the northwest, we find ourselves on the far-reaching Mongolian Plateau, outside the famous Great Wall of China. On its edges there is rain enough for wheat and a few other crops, but farther from the coast it becomes a vast, elevated desert, intensely cold in winter, hot in summer, and peopled mainly by Mongol nomads. The railroad bends west and ends at the great northern bend of the Yellow River. If we continue up the river we traverse the loess country, where mountains and valleys are covered with a fine-grained yellow deposit brought by the wind from the deserts farther to the northwest. Near the point where the upper Hwang Ho first turns north lies the city of Lanchow, nearly 1,000 miles inland at an altitude of about a mile. Lanchow resembles Teheran in Persia in its elevated inland location, and also in owing its size to irrigation by streams

from high mountains. It is quite unlike most of Asia's great cities, which are seaports, or at least lie in rich alluvial lowlands.

Manchukuo and Chosen

As we go north from China to Manchukuo and then east to Chosen (Korea) the railways, for the first time since we left India, tend to form a genuine net. The main reason is that here we come upon the work of the Japanese, just as we came upon that of the English in India and the Dutch in Java. Manchukuo contains one of the world's great plains, although it is small compared with those of Soviet Russia, or the Americas. It lies so far north that cold winters are a handicap. On the northern boundary along the Amur River the average temperature in January is —10° F., with minima as low as —45°. The summers, however, are pleasantly warm, and crops grow quite well. The mountains surrounding the plain are still colder, but few people live there. The chief cities are in the south, where it is not so cold. Antung lies on the coast where Manchukuo joins Chosen, while Mukden is located a little way back from the coast in the main plain not far from the Chinese border. A third great city, Harbin, lies north of the center of Manchukuo, so that its January temperature averages 4° below zero. Nevertheless, the winter is a time of active trade when one hears the creak of springless two-wheeled carts in which soy beans are being brought for sale by the farmers. In a country of this sort, without hard-surfaced roads, heavy rain and mud make it hard to travel in summer, but frozen ground with only a little snow makes it easy in winter.

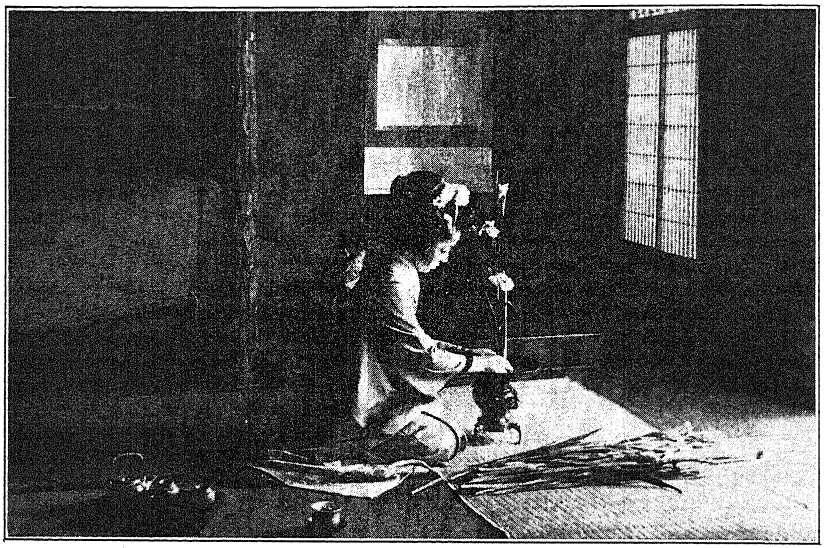
Chosen is a typical Asiatic peninsula with high mountains on the east and a lowland on the west. Under Japanese rule many short railroads have been built in the lower western part, but the east still remains little touched by modern changes. Keijo, or Seoul, in the middle of the west side, is the only large city.

Japan

In the railroad map (A569) Japan has a more European appearance than any other part of Asia. A similar approach to the European type is seen in many other Japanese conditions, such as the amount of manufacturing, the tendency toward colonial expansion, the use of electricity, and the development of great cities. If Japan were not so mountainous these conditions would probably be still more pronounced. Nevertheless, the mountains are a help to Japan. They complete the work done by the Sea of Japan in protecting eastern and southern Japan from the cold winds which make the winter so severe on the mainland. In January the east coast of Japan averages about 12° F. warmer than Peiping in the

same latitude on the mainland. The mountains also help the soil of Japan. Many of them are volcanic and supply an abundance of fresh, fertile soil to the lowlands. This helps to make the yield of crops much larger per acre than in any other part of Asia. Japan gets nearly two and a half times as much rice per acre as Java.

The productivity of the land, added to the energy of the people and their skill in manufacturing, allows Japan to have a population more than half as great as that of the United States on an area about the size of Montana. Naturally such a country has many large cities. On a mountainous narrow island one would naturally expect most of the cities to be



A—A Japanese Girl arranging Irises. Tea tray and bowl at left.

located on the seacoast. Such is preeminently the case, for among the fifteen Japanese cities with approximately 200,000 or more inhabitants only Kyoto lies back from the sea, and it is only a trifle farther from the water than is the early center of Los Angeles. The six largest cities and many others are located along the south coast in a distance of scarcely more than 250 miles.

Modern Tokyo is an enormous place, coming next after New York and London in size. The port of Yokohama and the smaller city of Yawata may be called suburbs of Tokyo to the same extent that Newark and Paterson are suburbs of New York. Going west along the coast one comes to Shizuoka, about as far from the great capital as New Haven is from New York. Then come Nagoya, with over a million people, and

Kumamato, about as far as Springfield. A little farther west at a distance not much greater than that of Boston from New York three huge cities, with about 5 million people among them, are located close together, namely, Osaka with 3 million people, the dull manufacturing city of Kobe, and the pleasant residence city of Kyoto, each with about a million. Farther west in a distance a little greater than from Kobe to Tokyo two moderately large cities, Kure and Hiroshima, with 200,000 to 300,000 people apiece, are located on the main island of Honshu, and two others, Fukuoka and Nagasaki, on the smaller island of Kyushu. Only Shikoku, the smallest main island, fails to have a large city.

The three other Japanese cities with more than 200,000 population are located north of Tokyo, far away from the rest—Sendai on the east coast, and Hakkodate and Sapporo in the northern island of Hokkaido. One of the most impressive facts about Japanese cities is that ten large ones lie along the south coast of Honshu in a distance about like that from Washington to Boston. This suggests that Japan's city population is comparable to ours. As a matter of fact, however, Japan has a much greater percentage of farmers than the United States.

Africa

The political divisions of Africa have relatively little connection with the physical features. They are the result of the seizure of the various parts of the continent by European nations rather than of gradual growth such as has occurred elsewhere. Such being the case, our best plan seems to be to begin at the north and work southward, looking at the main geographial conditions, the political allegiance, and the cities.

French Mediterranean Africa

Half way from west to east the north coast of Africa bends southward for about 300 miles. The strip of country west of this bend and north of the Atlas Mountains, which run parallel to the coast, is in some respects the best part of Africa. It lies closer to Europe than does any other part, and it has the Mediterranean type of climate. Although dry and hot in summer, it has fairly abundant rain during the mild winters, and hence is able to support a moderately dense population. Formerly this strip was divided into three countries, Morocco on the west, Algeria in the middle, and Tunis (old Carthage) on the east. Today all three are under French rule. Most of the people are farmers, and there is not business enough to support cities of the first rank. Nevertheless, each of the three countries has a city of more than 200,000 population, and two other cities approach this size. Thanks to the French the cities are the

foci of a small but fairly dense railway net from which two branches penetrate across the Atlas Mountains into the desert. The largest of the cities, Casa Blanca on the west coast of Morocco, is also the coolest. A cool current from the north washes this coast just as is the case on the corresponding coast of California. Marrakesh, a somewhat smaller inland city of Morocco, owes its size to irrigation from the Atlas Mountains. The colony of Algiers has two seaports, Oran, and its larger neighbor, Algiers, from which winter vegetables and fruits are shipped to France. Tunis has one large seaport, also called Tunis. Italians are numerous there, and Italy feels that she ought to own a place so close to Sicily.

The Sahara and Egypt

South of the northern French colonies a vast area about as large as the United States has not a single railroad from the Atlantic eastward until the railroads which roughly follow the Nile River are reached (A570). This blank space represents the great desert of Sahara. In the far west the coastal part, known as Rio de Oro (River of Gold), together with the neighboring Canary Islands, represents a remnant of the magnificent colonial empire once owned by Spain. More than half of the rest belongs to France, but Italy, Egypt, and England (in the Anglo-Egyptian Sudan) own parts. In reality the whole desert belongs with Arabia as a single great geographical unit, divided into sections by the narrow oasis of the Nile Valley and by the Red Sea. On the northern coast of Libya the railways are so insignificant that they are not shown in A570. The way in which they hug the coast indicates how dry and poor the land becomes as soon as the coast bends southward east of Tunis.

The oasis of Egypt has two distinct parts. One is the triangular Nile delta, and the other the narrow floodplain which borders the river most of the way upward across the desert. Close to 16 million people are here crowded into an area of 13,600 square miles. More than a million of these live in Cairo, which has been able to grow great because it lies at the head of the delta where several navigable distributaries of the Nile branch outward. Another half million are in Alexandria, Egypt's seaport at the western border of the delta. The next Egyptian city in size is Port Said at the northern end of the Suez Canal, but it has little more than 100,000 people. The rest of the Egyptians are mostly poor peasants who live in mud villages and work hard to plow, plant, irrigate, and reap small but fertile patches of land. With a thousand of them for every square mile, it is obvious that they can do little more than supply themselves with food of the staple kinds. Egypt is politically independent, but Great Britain retains the right to keep troops along the Suez Canal.

The Niger-Sudan Strip

A strip of land 500 or 600 miles wide extending from the Atlantic Ocean to the foot of the Ethiopian plateau and lying approximately 8° to 16° north of the equator is *sub*-Saharan in quality. That is, the barren desert here gives place to short grasses, then to taller grasses, and finally to scrub forest where small trees stand widely spaced among the grass as in an orchard. The western part belongs to France and the eastern to the Anglo-Egyptian Sudan, but little bites are taken out of French territory by Portuguese Guinea and the British possessions of Gambia and Sierra Leone on the west and by the northern parts of the Gold Coast and Nigeria farther east.

A long and scorchingly hot dry season makes this a poor place for agriculture, while the grasses, though coarse and rough, make it at least moderately good for cattle. Hence many of the people are nomadic keepers of cattle and goats. Irrigation, however, and the presence of groundwater near the surface of various low-lying tracts make it possible for a considerable farming population to live in certain places. Hence where the Blue Nile from Ethiopia meets the White Nile from Lake Victoria the combined towns of Khartum and Omdurman make a good-sized city. In the same way the water of the upper Niger supports small oases such as Timbuktu, which is famous as a starting place for journeys across the Sahara, by caravan in the past and now by a desert type of automobile. West of the shallow and fluctuating body of water known as Lake Chad (at the northeastern corner of British Nigeria) the rainfall and the presence of groundwater in certain broad hollows combine to produce fertility in parts of both British and French territory. Peanuts grow so well that this is the world's greatest peanut country. A series of semi-agricultural towns such as Kano and Sokoto sprawl over the land.

Equatorial Rainforest Countries

Only a relatively small part of Africa agrees with the common idea that tropical countries are covered with dense forests. This part begins on the west in southern Sierra Leone and the Negro republic of Liberia and extends eastward through Belgian Congo to the high mountains which lie west of Lake Victoria and the northern part of Lake Tanganyika. It extends southward to about 5° S. Within this area the gloomy forests, almost impenetrable and uninhabitable, are interspersed with more habitable tracts of smaller, more jungle-like forest where a crude agriculture is practiced. There are even some grassy tracts where special types of soil and drainage prevail. The population, though sparse and living mainly near the rivers, is more dense than in drier areas of the scrub-

forest type farther from the equator. A good many railroads penetrate a few hundred miles into the interior. Some of them end where the construction of tracks becomes difficult because it is necessary to climb onto the great plateau which forms most of Africa south of the Sahara. Another reason for the ending of the railroads is that they reach their destination, which is a zone where the dense forest gives way to jungle, a region fit for agriculture. In a region of this kind in British Nigeria the city of Ibadan, about 100 miles from the coast, is the only really large city in a north and south distance of 4,000 miles. Including its farming suburbs it has a population of nearly 400,000. Its seaport, Lagos, whence great quantities of palm oil and palm kernels are exported, is the largest on the whole African coast except in the far north and extreme south.

Far in the interior of the equatorial forest region a few short railroads have been built to get around the rapids of the Congo River. There are still plenty of places, however, where one can go straight across Africa along a straight line without crossing a railroad.

High Equatorial Plateaus

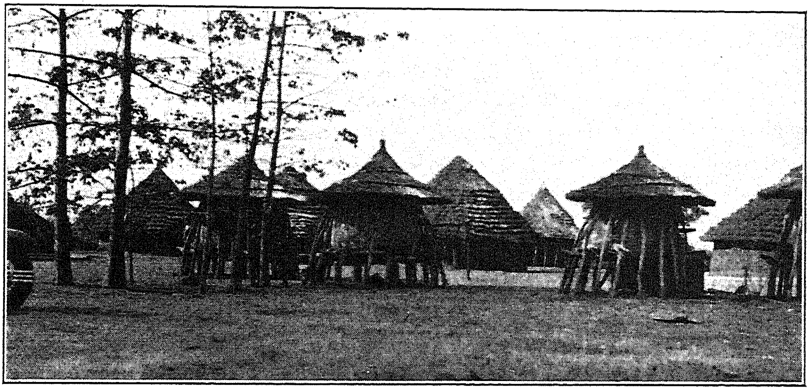
One of the handicaps of equatorial Africa is that the interior is cut off from the coast by mountains on the borders of the main plateau. The Congo Basin is separated from the Indian Ocean by an especially high part of the plateau from which rise great volcanic mountains (Ruwenzori, 16,800 feet; Kenya, 17,000; Kilimanjaro, 19,300). On the west it is separated from the Atlantic by a band of mountains which form the rim of practically the whole of the plateau of the southern half of Africa. These mountains rise to a height of 13,370 feet in Mt. Cameroon near the corner where the African coast turns south about 5° north of the equator. The west side of this active volcano vies with northeastern India (Assam) and Hawaii as one of the world's rainiest places, with an average of well over 400 inches per year.

The northern end of the highest part of Africa begins in the Italian colony of Eritrea near the coast of the Red Sea. It extends southward through Italy's recent conquest, Ethiopia, to the British colonies of Kenya and Uganda and to the eastern part of Belgian Congo. In the large sections where these plateau regions lie above 5,000 feet the weather is never hot. At Addis Ababa, the little capital of Ethiopia, 8,000 feet above the sea, and also at Nairobi, the smaller capital of Kenya (5,450 feet high on the equator), the warmest month averages about 66° and the coolest 59°. Both places have heavy but not excessive rain for a few months. During several other months there is scarcely enough rain to keep the ground wet, but this does little harm because of the relatively low temperature. Such conditions make a climate which would be delightful for Euro-

peans if it were not so monotonous. They also cause large areas to be covered with grass so that cattle are numerous, and many native tribes are nomadic.

There is plenty of vegetation, too, especially on the slopes, which are often forested. Plantation crops such as coffee, as well as temperate crops such as corn and even wheat, can be raised in favorable localities. This has led many people to believe that the plateaus are a white man's country, but isolation and the presence of a fairly dense African population give the white settlers a hard time. Nevertheless, thousands of British settlers seem to be firmly established on the higher parts of the Kenya Plateau.

Of similar significance is the vigorous response of the natives to the high plateaus. Ethiopia resisted the encroachments of the white man



A—Bins for Storing Millet in Uganda.

These bins were built near Soroti by order of the British government to store food against times of scarcity.

longer than any other part of Africa. Before the coming of the Italians in 1936 it had a well-organized government according to the African standards. Its people were so warlike and well trained that they defeated the Italians in an earlier war. In the end they were conquered by means of the mechanical equipment which Europeans are able to command. When the Ethiopians go to neighboring lowlands, such as the cotton-raising districts watered by the Blue Nile south of Khartum, they are considered unusually good workers. In similar fashion Uganda, on its high plateau north of Lake Victoria, had a remarkably well-organized native government before the arrival of the British. Today the natives there have more self-government than in almost any other part of Africa. Their part of the plateau lies at such a height (4,000 to 6,000 feet) that

the climate is free from much of the enervating heat felt at lower altitudes. Nevertheless, it is not high enough to prevent the banana-like plantain from being the staple crop.

Southern Scrublands and Plateaus

Africa is unfortunate in having large areas where highly seasonal rainfall, a long dry season, and poor soil cause the natural vegetation to be either grassy savanna or a scrubby kind of grassy forest where agriculture does not thrive. Except for the high plateaus the eastern bulge of Africa from Eritrea at the southern end of the Red Sea through the three Somalilands to eastern Kenya is mainly a sparsely populated grassland or savanna. Farther south most of the continent from Tanganyika and Mozambique on the east through the two Rhodesias to Angola is covered with poor scrubby forest. A long dry season hampers vegetation so much that in vast areas few trees of any species ever attain a diameter of 12 inches at a height of 4 feet from the ground, and many species never get beyond 4 inches no matter how old they are. In the far southwest, north of the Orange River, the country degenerates into a genuine desert, the Kalahari. Its bushy, sandy wastes are the home of the primitive cattle-raising Hottentots and diminutive Bushmen. Except in parts of Somaliland and Mozambique practically the whole of Africa from Ethiopia to Angola and the Union of South Africa consists of a plateau at least 3,000 feet high. Inasmuch as the plateau is higher on the edges than in the middle the great rivers have to plunge over falls or rapids, such as the falls of the upper Nile, Victoria Falls on the Zambesi, and the rapids of the Congo and Orange rivers. Such conditions have made it impossible to penetrate far into Africa by water and have helped to keep the continent backward and unknown.

Largely because of the unfavorable dry seasons, aided by the unfavorable relief, a part of southern Africa larger than the United States has a population of scarcely 25 million—only one fifth of ours. This area includes practically all the continent east of the high plateaus of Ethiopia and Kenya and south of latitude 5° S, but omitting a narrow coastal strip in the Union of South Africa. Contrast this with Egypt, which has about 220 times as many people per square mile. Even British Nigeria, with nearly 20 million people in 340,000 square miles, has 6 times as dense a population as the scrub forests of the east and south.

The low commercial value of this huge section of Africa is evident from the fact that the railroads which cross it were not built primarily to develop it, but to reach relatively small regions where the conditions of rainfall and agriculture are unusually good. For example, on the east

side of Africa the most northern group of railroads crosses a desert in order to reach irrigated regions along the upper Nile and at the northern base of the Ethiopian Plateau. The next one, very short, taps the high plateau of Italian Eritrea. Farther south a railroad from Jibuti in French Somaliland, near the south end of the Red Sea, was built to connect the relatively fertile Ethiopian Plateau with the ocean. Italy took this away from France in the second World War. The next railroads, far down the coast, start from Mombasa in Kenya and from a little port in Tanganyika near the islands of Pemba and Zanzibar. They traverse hundreds of miles of unproductive scrub and grass in order to reach the higher and more productive plateaus of the interior. Finally from Portuguese Mozambique one railroad runs north to Lake Nyassa, the northern part of which lies between especially high and hence fertile plateaus. Another goes by way of Victoria Falls on the Zambesi to the copper region around Katanga near the border between Northern Rhodesia and Belgian Congo. Then one branch reaches the west coast at Benguela in Portuguese Angola and another meets the navigable Kasai branch of the Congo. This whole line across Africa would probably never have been built had it not been for the copper mines.

In Madagascar a similar situation prevails. The one railroad heads for Antananarivo on the central plateau at a height of 4,600 feet. On its way it traverses a dense rainforest too wet for agriculture. Such a forest forms a ring around the island, shrouding the slopes that lead to the plateau. The relatively low southern part of the Madagascar Plateau is covered with the same kind of poor scrubby forest as the mainland.

Another evidence of the unproductive nature of these southern scrublands and plateaus is that, although the British have talked for generations about a Cape to Cairo railway (from Capetown in South Africa to the Mediterranean Sea in Egypt), such a railway still remains largely unfinished.

Of course in the better parts of this whole scrubland there are many valleys and low places beside watercourses where the trees are large. There are also considerable areas here and there which are good for plantations. Nevertheless, as a whole the entire area from Eritrea through Tanganyika and Rhodesia to Angola and all but the southern part of the South African Union suffers from drought. Failure of the rains to arrive promptly at the end of the dry season often destroys the profit on plantations and makes the natives suffer from actual scarcity of food. Because of such difficulties, and because this kind of climate favors grass more than trees, many of the natives here, as well as in similar parts of Africa south of the Sahara, depend on cattle and are more or less nomadic. The fact that aside from Ibadan the whole of Africa between the Mediter-

ranean coastal section and Johannesburg in South Africa has no city of more than 200,000 population is highly significant in this respect.

South Africa

Between latitudes 25° and 35° south of the equator an east-west distance of 1,000 miles in South Africa repeats certain main features which are spread out over 8,000 miles in the same latitude north of the equator. On the west the small Kalahari Desert corresponds to the vast deserts of Sahara, Arabia, southern Persia, and the Indus Valley. Farther east the high mountains of Basutoland, rising to a height of 6,000 to 11,000 feet on the eastern border of the South African plateau, correspond to the Himalayas, Tibet, and Yunnan in Asia. The energetic Basutos, who constitute a purely native and almost independent British protectorate, correspond to the independent Himalayan states of Nepal and Bhutan. Then, farther east, the South African coast of Natal, with its abundant rain in the warm season and its semi-tropical forests, is similar to the well-watered and well-populated region of South China.

A little farther from the equator, that is, above 33° from it at both ends of Africa, a western area has a climate of the Mediterranean type with winter rain and summer droughts. In South Africa the area of this sort is very small, extending scarcely more than 100 miles north and east of the Cape of Good Hope. Nevertheless it corresponds closely to the French colonies of Morocco, Algeria, and Tunis. Capetown, although smaller, takes the place of the cities of Casablanca, Algiers, and Tunis.

There are differences as well as resemblances between the far north and the far south in Africa. One great difference is that inland from the south coast the land at once rises to a high plateau and stays high for 2,000 miles whereas in the north the land drops to a much lower level south of the Atlas Mountains. This, together with the nearness of the sea, makes the main part of the Union of South Africa much more habitable than the same latitudes in the Sahara. Nevertheless, agriculture without irrigation is difficult except in the highest sections and on the east slope. Another difference is that in South Africa, largely because of the coolness of the plateau, a fifth of the people are of European stock, but in French North Africa less than one tenth are of such stock.

A third difference is that South Africa is rich in diamonds and especially gold. Each year the southern part, the Cape Province, produces from 10 to 20 million dollars' worth of diamonds, while the northern part, Transvaal, produces 250 to 400 million dollars' worth. Because of its gold mines Johannesburg in Transvaal has become the largest real city in Africa aside from five near the north coast, for Ibadan in Nigeria

consists of farmers. Lack of cities and industries is one of the most characteristic features of Africa.

Facts and Principles

In the preceding review of the continents we have been concerned primarily with refreshing our memories as to the *location* of all sorts of geographical features. We have spoken mainly of physical conditions, cities, and the distribution of population. Again and again, however, we have referred to occupations, modes of life, and habits peculiar to special parts of the world. We have repeatedly seen that in particular kinds of geographical environments people tend to behave in certain distinct ways. In an elementary study of geography it suffices to realize this fact and to have a general idea that mountains, for example, are associated with a different kind of life from plains. In a mature study, however, it is essential to dig more deeply into the basic principles which underlie man's relation to his physical environment. That is what we shall do in the rest of this book. The familiarity with locational geography which we have acquired from the last three chapters will help greatly in enabling us to apply the prinicples to specific parts of the earth.

QUESTIONS, EXERCISES, AND PROBLEMS

1. The location of the Russian railways in A569 is largely determined by the following conditions: (1) the capacity of the country for profitable agriculture without irrigation, (2) oases irrigated by rivers flowing northward or westward from the great mass of mountains along the country's southern border, (3) desire for a connection between European Russia and the Pacific Ocean, (4) desire to have a Pacific railroad which cannot easily be attacked by an enemy. Pick out roads dependent on each of these conditions.

2. Make a list of six or eight Asiatic regions (either countries or parts of countries) in the order of the density of their railway nets. Explain the conditions of relief, climate, and bodies of water which favor railroads here rather than in other parts of Asia.

3. In A569 the northern part of Asia has been omitted in order that all the continental railway maps may be on the same scale. If the rest of the continent were included how would the areas without railroads north and south of the Siberian Railway compare in size with one another and with the United States?

4. In what part of Asia will railroad building probably proceed most rapidly in the future? Why? What great cities still have no railroads? Why?

5. This exercise uses almost the same method as exercise 1 of Chapter VIII but includes more countries, namely, Japan, China, India, Italy, Germany, Great Britain, and the United States. On outline maps which have *as nearly the same scale as possible,* shade lightly the 70,000 square miles (an area the size of Great Britain aside from the Scotch Highlands) which include the greatest possible number of cities with over 100,000 population. (Wall maps and the *Statesman's Yearbook* may

help you in this.) Indicate the cities by heavy dots. Compare the number, size, and total population of the cities within these areas. What is thus indicated as to (1) the conditions under which many cities are concentrated in small areas; (2) the difference in this respect between Europe, Asia, and America; (3) the reason for the growth of cities?

6. Using a physical map as a guide (perhaps a wall map), lay out a gently curving route from the most southerly bend of the upper Yangtze River north of Yunnan, north westward to Lhassa in Tibet. Lay it out in such a way as to present the maximum difficulty because of great rivers flowing in deep canyons with lofty ridges between them. Name the rivers that you would cross and the cities to which they finally go.

7. Write a comparison between Africa south of the Sahara and South America in the same latitudes, paying special attention to the (1) relief, (2) rivers, and the number and distribution of (3) people, (4) cities, and (5) railroads.

8. Make a similar comparison between Australia and the part of Africa in its latitude.

9. Make a list of the names and political allegiances of the political divisions between Liberia and the Belgian Congo. Find out how well the encyclopedia describes the contrast between the heavily forested coastal sections, the more lightly forested inland sections, and the grassy forest or savanna farther north.

10. On an outline map of Africa shade the various divisions according to their political allegiance. Then, on the basis of a vegetation map (page 363 or, better, some atlas), make a list showing the relative degree to which each colonial power owns tracts of (1) desert or poor grassland, (2) tropical savanna or scrub forest, (3) tropical rainforest. Sum up the relative advantages of each power, remembering that the best parts of the tropics are those which are intermediate between rainforest and scrub forest—jungle, as we shall see later.

PART V

PHYSIOGRAPHY AND HUMAN PROGRESS

CHAPTER X

HUMAN ACTIVITIES IN MOUNTAINS AND PLAINS

Civilization among Mountains

The world's ideas as to the relative value of mountains and plains have changed somewhat in recent generations. Nevertheless, mountains are still regarded mainly as regions of scanty resources and sparse population. In general the words "mountaineer," "highlander," "mountain white," and "hillman" suggest people who differ from plainsmen not only in habits and modes of life, but likewise in physique and character. The dictionary defines a mountaineer as "a person who lives in a mountainous country or district; hence a boorish person." The word highlander makes us think of bold raids such as are described in Walter Scott's novels. Mountain white suggests people of the white race who are backward and uneducated because they live in rugged and inaccessible regions. To many people hillman means wild tribes in the mountains of northern India. Even in highly civilized countries mountaineers are likely to be poorly educated, provincial, and a little behind the times. In less-civilized regions mountains are the home of secluded people such as the Tibetans, of untamed tribes such as the Afghans, or of warring groups like those of the Balkans and the Caucasus.

On the other hand, there is a tendency to think of mountaineers as sturdier and manlier than the people of plains. Then, too, a mountaineer often means a man who goes to the Alps, the Rockies, the Himalayas, or other high mountains for the pleasure of climbing. Among civilized people the mention of mountains probably calls up the idea of vacations and good scenery more often than anything else. It may also call up the idea of mines, lumber camps, water power, or water supplies for great cities. Many kinds of tropical plantations thrive better among mountains than in lowlands. Mountains also make the climate of many places better than it would be otherwise. Many of these benefits of mountains are

comparatively new, or at least have been realized only recently. Mines, water power, and recreation, for example, were not one tenth as important a century ago as they are now. Hence today the value of mountains is appreciated far more than formerly.

Civilization in Plains

In spite of all this, plains and lowlands are still of much more value than mountains. When plains are mentioned, we think of prosperous people living in flourishing villages among fertile fields and rich farms, or else in thriving cities. The people of the farms and villages may be conservative, but not so much so as those of the mountains.

As we think of plains, we recall the growth of early civilization in the fertile plains of Egypt, Mesopotamia, and elsewhere. We realize that today the great nations of the world all have their densest population and greatest cities in the plains, or at least in the lowlands where the slopes are gentle. Think of the world's great cities: London, Paris, Berlin, Leningrad, Vienna, Budapest, Constantinople, Bombay, Calcutta, Peiping, Tokyo, Rio de Janeiro, Buenos Aires, New York, Chicago, and many others. Not one of them is actually among the mountains, although some like Rio de Janeiro, Bombay, and Vienna, are close to their foot. Even cities that are high up, such as Johannesburg, Nairobi, Mexico City, Denver, Quito, and La Paz, seek level land or at least the bottoms of valleys. The plains of the world, together with the lowlands where the slopes are gentle, are evidently the most desirable places for human habitation and progress.

Kinds of Relief

Three Great Types of Mountains. The wrinkling and uplifting of the earth's crust have produced several kinds of mountains. One kind is caused by long breaks or *faults* extending hundreds of miles. The two sides of the fault move differently, so that one finally may stand thousands of feet higher than the other, thus forming a tilted *block mountain.* Such mountains are generally steep on the faulted side and more gentle on the other. The Wasatch Range in Utah, for example, has a steep fault face on the west side and a gentler slope toward the east. In the Sierra Nevadas the reverse is true. Other mountains are formed by a wavelike folding of the crust as in the Jura Mountains of France, where each ridge represents a wave. Such simple *folded mountains*, however, are rare. Most great mountain ranges consist of a crumpled mixture of folds and fault blocks. Often the blocks have been pushed in various directions or even one over another. The structure of these *complex*

mountains is reflected in the irregularity of their ranges and ridges; as may be seen in the Alps, Rockies, and Himalayas.

How Mountains are Carved: Valleys. Only rarely is the present form of mountains due to the faulting, folding, and crumpling that they have passed through. These processes are very slow according to human standards. Hence, even while they are in progress, rivers and to a much less extent glaciers have a chance to carve valleys and carry away enormous amounts of rocks. So far has this process gone that among the Rocky Mountains only rarely is it easy to detect the original form due to movements of the earth's crust. Every little stream, and even every tiniest rivulet formed during a shower, carries away part of the substance of the mountains and tends to form a valley. No matter how hard the rock may be, a river or even a small stream can eventually carve a valley thousands of feet deep and then with the help of its tributaries can widen that valley and reduce the steepness of its slopes until finally the very mountain tops melt down. As this process goes on the mountains become low and rounded like the White Mountains and the Adirondacks. The only parts that still stand high are those where the rock is particularly hard and resistant. Such mountains are called *residual*, and any one of them may be called a *monadnock* after a mountain of that name in southern New Hampshire.

During the early stages of their life history, when the valleys are steep-sided and often very deep and precipitous, and when parts of the form due to the original uplift of the crust are still visible, mountains are spoken of as *young*. When the original topographic forms are nearly or quite gone, but the slopes are still very steep and rocky, the influences upon transportation and other human activities are at their greatest, as may be seen in many parts of the Andes. In time, however, the valleys begin to widen, the slopes become less steep, and the original form due to uplift disappears, as has happened in the Rockies. When the slopes, although still steep, are mostly covered with soil instead of bare rock, the mountains are fully *mature*. Their effect on civilization, however, is still very pronounced. Even when they become *old* with gentle slopes, wide valleys, and no great height, this still remains true to a certain extent. In their final stages, however, the mountains are worn so low that they are reduced to a *peneplain*, that is, almost to a plain. They then form a low rolling country with only a few monadnocks rising here and there as in the Piedmont region of the Atlantic slope, and are practically plains.

How Plains Are Formed. Plains are formed by the wearing down of any kind of region to a gentle relief, or else by the deposition of materials brought down from higher regions. Most plains are of this latter sort. Some, such as the "high plains" of Colorado and Texas

or the basin plains of Utah and Nevada, have been formed by streams which flow out from the neighboring mountains. When the streams lose their velocity on reaching the lowlands, they at once begin to deposit their loads of gravel and silt. They thus block their own channels and are forced to flow in new courses. During the lapse of ages they flow now here and now there until finally they build almost level plains covering hundreds of thousands of square miles. Other plains, such as a large section of the central United States, were once part of the sea floor, and hence for millions of years received vast deposits of fine clay and silt brought by rivers from the lands. Then the movements of the earth's crust finally brought them almost unchanged to a level above that of the oceans.

Plateaus and Basin Regions as Combinations of Mountains and Plains. Vast portions of the earth's surface, such as the plateaus of Tibet, Central Africa, Peru, and Arizona, and the basin regions of Persia and Utah, combine the features of mountains and plains. In the plateaus a plain or region of low relief has been uplifted, and streams have cut valleys in it. Thus the valleys and their slopes have the character of mountains while the uplands have some of the characteristics of plains. On the whole, however, most plateaus, in the more limited sense of the word, are so cut up that they are more like mountains than plains, as is clearly evident in the Allegheny Plateau and southeastern Brazil. In the basin regions, on the other hand, the deposition of gravel, silt, and clay brought in by streams has often converted parts of a mountainous country into plains, as may be seen by the way in which the peaks of half-buried mountains stick up through great plains of gravel in parts of Nevada and Persia. Plateaus and basins are sometimes combined, as in Mexico, where Mexico City is located on a high plateau but also in a basin which is floored with a plain of soil brought down from the mountains.

It would be highly profitable to study the various kinds of mountains, plains, and plateaus in order to see how each exerts its own special influence on man. We should find that some consists of hard rocks and some of soft. In some the rock layers lie horizontal; in others they are tilted at all sorts of angles. Some rocks are of igneous origin, having reached their present position while molten. Others are sedimentary, having been laid down by water. Even under similar conditions of climate these varied conditions cause mountains to vary greatly in the degree to which they hamper transportation and agriculture, retard education and progress, or favor the sightseer and hunter. We should find that although many plains have relatively deep soil and dense population, and are comparatively easy to traverse, they differ greatly in these respects. But we should also find that some plains are ruined

by being too flat and wet, and their inhabitants suffer terribly from floods and famines. Unfortunately, the limits of space oblige us to confine our study to the contrast between the life of typical mountains and typical plains. We shall talk chiefly about the mountains, however, because this is the only chapter where their influence is fully discussed. Plains are so important that they form the chief theme in the chapters on soil and agriculture.

Altitude and Climate in Relation to Relief

(1) *The Effect of Altitude.* Life in mountains differs from that in plains for three chief reasons, namely, altitude, climate, and slope. Altitude alone is relatively unimportant. Some people with heart trouble, to be sure, cannot live even at an altitude of 5000 feet, and many find difficulty in breathing at altitudes of 10,000 feet or more. Nevertheless when people stay at high altitudes, their bodies soon become adapted to the new conditions. An increase in the number of red corpuscles enables the blood to absorb oxygen more rapidly, and thus the rarity of the air, which is the great difficulty at high altitudes, is robbed of much of its effect. When people come down from the mountains this excess of red corpuscles makes them feel strong, but it quickly passes away. This prompt change in the blood enables people to adapt themselves to any altitude where the climate and relief make it possible to get a living. Denver, for example, has become a great city a mile above sealevel, Mexico City is half a mile higher, Quito prospers at an altitude of nearly 2 miles, and certain villages in the Andes and Tibet raise barley and sheep nearly 3 miles above the sea. In each case a high plain makes it possible for the city or village to grow up in spite of the altitude.

It should be remembered, however, that only a few people suffer until an altitude of 6,000 feet or more is reached. Such altitudes are practically unknown in the eastern two thirds of the United States and form scarcely a quarter of the western two thirds. In Europe they are rare, in Australia unknown, and in Africa limited to Abyssinia and a few minor areas. Only in the Tibetan region of Asia and the Andean region of South America are there large areas where altitude alone makes it difficult for people to live.

(2) *How Climate Differs in Highlands and Lowlands.* The contrasted climates which arise from differences of altitude are far more important than the direct effects of altitudes. In the loftiest villages of the Andes and Tibet the villagers think little about the altitude, but much about the climate. This is because altitude influences climate in three main ways: (*a*) Temperature decreases with altitude. In the free air the fall is about 1° F. for 330 feet of altitude in summer

and for 400 feet in winter. The fall is more marked where mountains rise steeply above a lowland, as in the Alps, than in regions like the Great Plains where one can rise from sealevel to Denver almost without noticing any grade. Nevertheless the average yearly temperature at Denver is about 3° lower than at Indianapolis, which lies in the same latitude but 4,500 feet lower. (*b*) The greater the altitude the more variable is the temperature. The rarity of the air allows the sun's heat to pass through it readily. Thus the earth's surface is quickly warmed, but the same condition also allows the earth's heat to pass away rapidly at night, so that there are great extremes. The relief also causes variability, for cool air may flow down a valley at night and warm air rises by day. (*c*) Mountains are also more cloudy and rainy than plains, for the currents of air that approach them must rise. Hence the air is cooled and its water vapor condenses into clouds and rain. On a perfectly clear day on the plains of California one can often see great banks of clouds enshrouding the crests of the Sierras only 40 miles to the east. While the dry brown grass of the plains shows that no rain has fallen for months, the dense pine forests of the mountains, and the little brooks flowing amid rich green grass or thick brakes of flourishing bushes, betoken rain in plenty.

Although climatic differences between highlands and lowlands are everywhere important, they influence man most in regions close to the coldward margin of human occupation and within the tropics. England lies so far north that in the lowlands the summers are not warm enough for corn, and just barely warm enough for wheat, oats, and potatoes. Accordingly a rise of 1,500 feet, or in some sections only 1,000, is enough to make agriculture impossible and to prevent the growth of forests. In the Devonshire regions described in Blackmore's *Lorna Doone* the contrast between the seacoast and the upland moors is very impressive. Near the coast and in the valleys luxuriant trees, fine gardens, and rich hayfields surround comfortable villages and picturesque farmhouses, many of which are thatched with straw. The mild winters actually permit the growth of semi-tropical plants such as the fuchsia. Only a few miles away the cool summers of the rolling uplands 1,500 feet higher permit little except grass, heather, drifting mist, and shepherds.

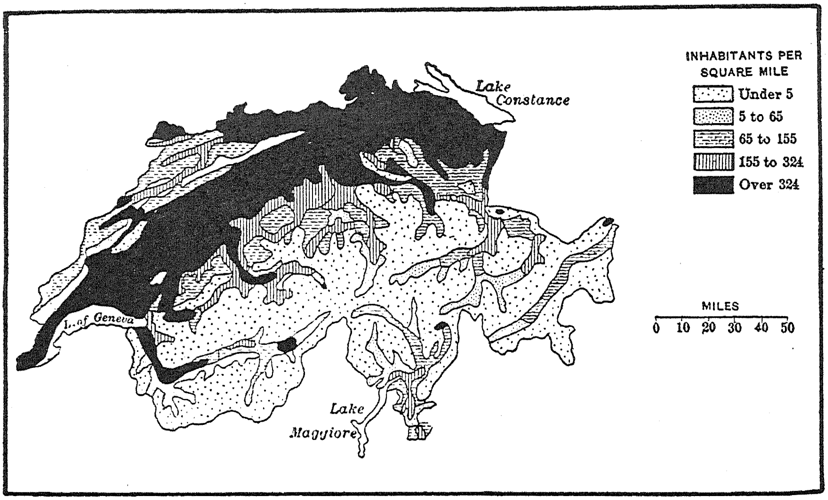
In tropical countries high altitudes are beneficial because of the cool air. Near sealevel the temperature much of the year averages close to 80° F. This is too warm for comfort, health, or efficiency. Up to an average of about 72°, however, high temperature is not particularly uncomfortable or unhealthful and does not greatly diminish efficiency except as it remains monotonously at the same level. Accordingly an altitude sufficient to lower the temperature of the warmer months by

8° or 10° is a tremendous help in the tropics. Even 2,500 feet is enough to produce a wonderful improvement, and 5,000 feet of altitude at the equator makes a most delightful climate, in spite of the monotony. Hence the coffee-raising plateau of southern Brazil, 2,000–3,000 feet high, is a vastly better place than the Amazon Lowlands. High Kenya and Uganda are similarly far ahead of the coasts of equatorial Africa. Because of the coolness of tropical highlands the north-and-south railroad in South America as well as in Africa has begun to be built amidst the difficulties of the plateau rather than in the eastern lowlands. Bogotá, Quito, Arequipa, and La Paz at elevations of 8,000 to 12,000 feet are healthful and progressive places in comparison with the hot, steaming jungles of the parts of Colombia, Ecuador, Peru, and Bolivia at the eastern base of the Andes.

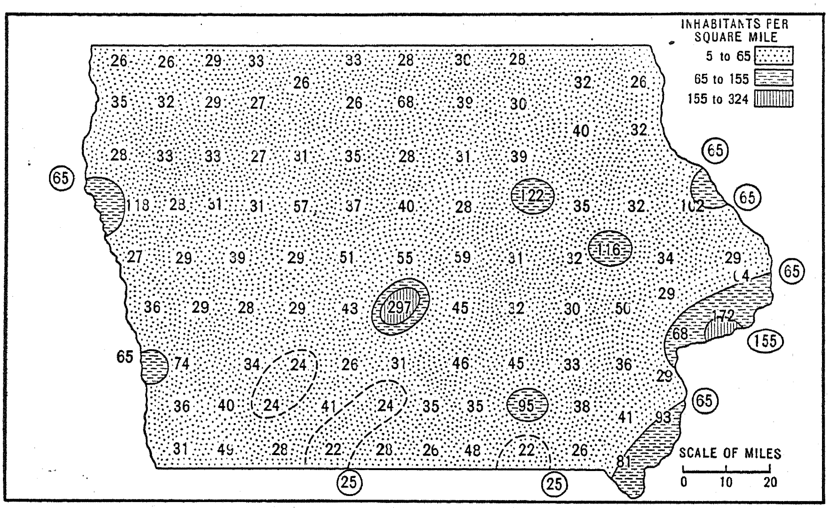
The Great Importance of Slope

(1) *Location of Population.* Human activities are influenced vastly more by the slopes of mountainous and rugged regions than by their altitude. The reason, of course, is that slopes too steep for the best use are very widely distributed. The effect of slope is clearly seen in the distribution of the population among mountains as compared with plains. In A210 notice how irregularly the people of Switzerland are scattered. There is a great concentration in the northern lowland, where most of the people live, while among the mountains the inhabitants are distributed here and there without apparent order, but really along the main valleys. This is partly because the higher parts of Switzerland are too cold for agriculture, but the steepness of the slopes has a great deal to do with it. Contrast A210 with B210, a similar map of the plain of Iowa. The people are distributed so evenly that 71 out of 99 counties have between 24 and 40 people per square mile. About 60 per cent of the townships, each of which contains 36 square miles, have between 500 and 1,000 inhabitants. A few cities have grown up, but they are quite evenly spaced throughout the state and not concentrated in one section, as in Switzerland. The reason is obvious: In Switzerland people cannot live in any large numbers in the rugged portions and must concentrate in the valleys; in Iowa the plain is so uniform that people can live almost anywhere.

Mountains and plains show a strong contrast in the *density* as well as in the distribution of their population. This is due to the combined effects of slope and climate. In California a beautiful region called Alpine County lies 80 miles east of Sacramento County, which is only a little larger and much less beautiful. Here are the populations of the two in successive census years.



A—Density of Population in Switzerland. An example of extraordinary differences in density due to relief. Practically all the people are concentrated in the northern lowland, while many parts of the mountains do not have one inhabitant per square mile.



B—Density of Population in Iowa. An extraordinary example of even distribution of population in a plain with a few denser areas due to cities which are mainly located on rivers. Note that the grades of shading are the same as in the preceding map of Switzerland.

	Alpine	*Sacramento*
1890	667	40,000
1900	509	46,000
1910	309	68,000
1920	243	91,000
1930	241	142,000

Why does the population of a county with only 1 person in 3 square miles decline steadily, while that of another with 145 people to the square mile still grows? The answer is simply that Alpine County is one of the most mountainous parts of the United States, while Sacramento County is mainly a smooth and very fertile plain.

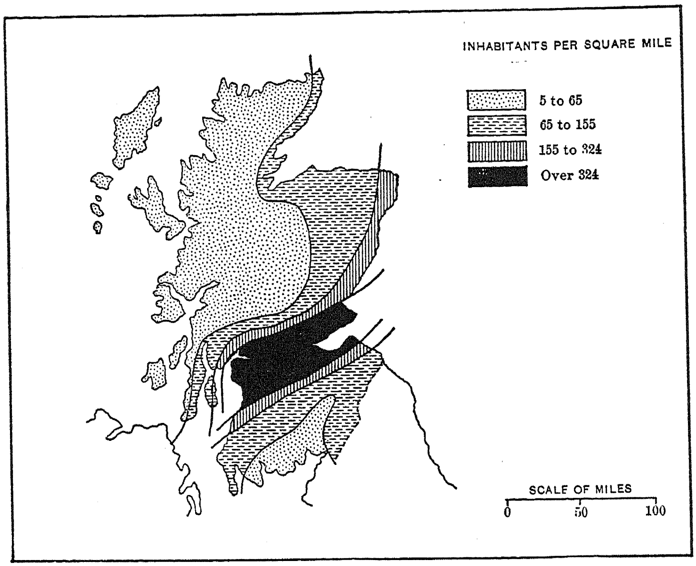
Such contrasts between mountains and plains are widespread. In India the little country of Bhutan on the rugged southern slope of the Himalayas contains only 12 people per square mile, while close at hand the level plain of Bengal has over 500. Even where the contrast between mountains and plains is less striking there are great differences in the density of the population. For instance, in A212 notice how the people of Scotland are concentrated either in the southern lowland from Glasgow to Edinburgh and Dundee, or along the plains of the eastern coast toward Aberdeen. The rugged highlands both in the north and south have so few people that they appear almost white on the map.

(2) *Transportation.* (*a*) ADVANTAGES OF PLAINS OVER MOUNTAINS. The slopes of mountains are an especially heavy handicap to transportation. In mountainous regions the roads and railroads must go up and down hill. In going up hill a load must not only be carried forward, but also must be lifted against the pull of gravity. Another difficulty is that the roads must often wind or go out of their way to follow valleys. Thus they traverse much greater distances than are necessary on a plain. Compare the curved railroads in the mildly rugged northern part of New Jersey (A213) with the straight railroads in the level plain of southern New Jersey.

The hard work and long distances on mountain roads combine to cause three other disadvantages which are not felt in plains. First, transportation is slower. For example, on the level stretch between New York and Philadelphia a fast train on the Pennsylvania Railroad travels 60 miles an hour, whereas on the mountainous stretch where the road climbs the Allegheny Escarpment over the Horseshoe Curve between Altoona and Johnstown the average speed is only 20 miles an hour. Second, the steeper grades and sharper curves cause greater wear and tear. An automobile used on the hilly roads of rugged Vermont is often junked after traveling only half as far as it might go in level Kansas. Third, the uphill work, the slow speed, and the long windings of mountain roads join with the wear and tear to increase the cost of

transportation among the mountains as compared with plains. For instance, an automobile that makes 16 miles on a gallon of gasoline in Nevada may make only 8 when it climbs the Sierras into California and may also have to travel 20 miles in order to reach a place 10 miles away as the crow flies. Moreover, the cost of making and especially of repairing roads and railroads is often ten times as much in the mountains as in the level plains.

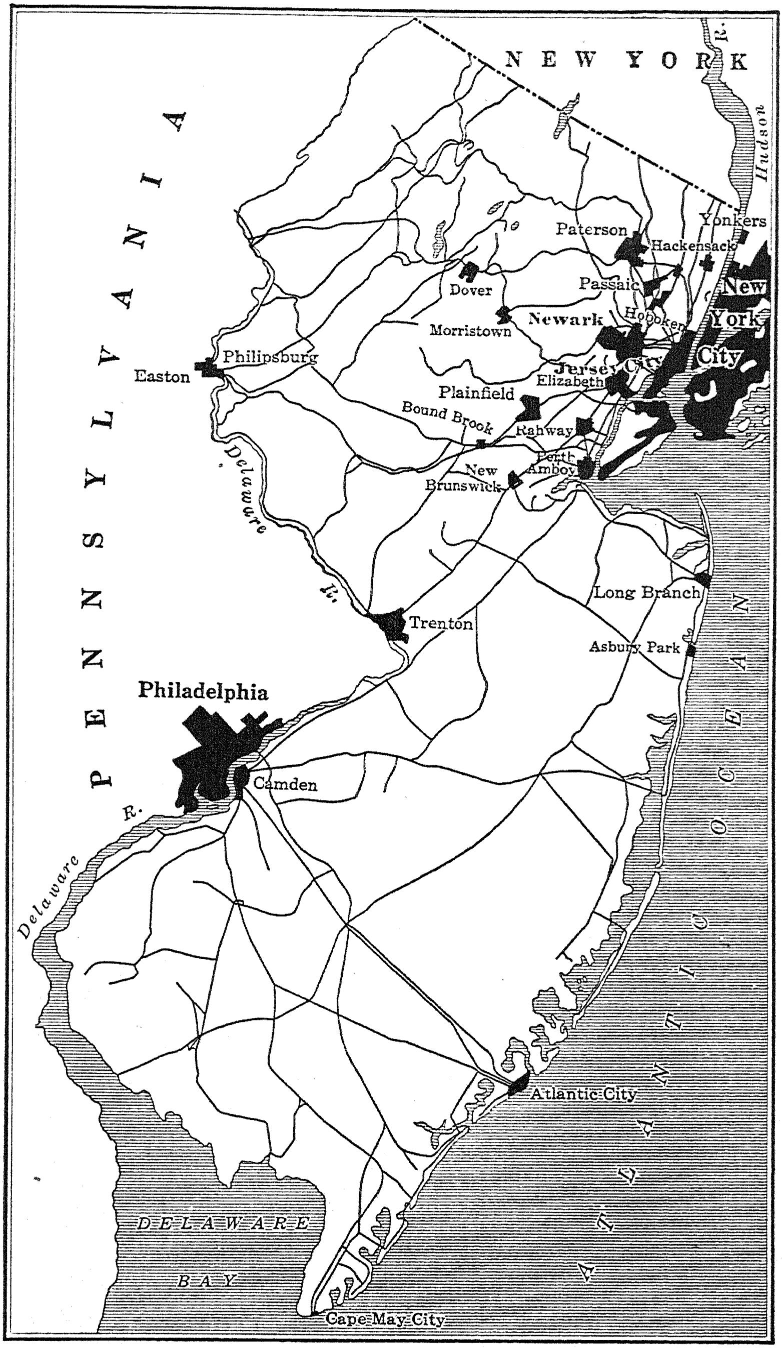
Looking at the matter from the standpoint of plains we find that they have the following advantages: they permit transportation routes (1) to avoid hard grades, (2) to go in any direction, and to follow straight



A—Distribution of Population in Scotland.

lines, (3) to form as dense a network as the inhabitants require, (4) to be adapted to rapid travel, and (5) to be built and maintained cheaply.

(*b*) MEANS OF TRANSPORTATION IN MOUNTAINS AND PLAINS. One of the most striking differences between mountains and plains is that among mountains primitive methods of transportation persist far longer than on plains. Even in highly civilized countries, such as Switzerland, pack trains are still common among the mountains, although unknown in the plains. In plains it is possible to build numerous railroads and motor highways both because the cost of construction is moderate and because there are many people. Plainsmen are more numerous than mountaineers, and they produce and consume more per capita. Hence they not only provide more business for railroads, buses, and truck lines, but



A—Railroad Map of New Jersey.

also can invest more, or pay more in taxes for the construction of new transportation facilities. Even the airplane is far more adapted to plains than to mountains. It requires broad level spaces in which to land. It is also much safer over the plains, for there is no danger of running into the hills in fog or cloud.

Because of these handicaps many mountainous regions have no railroads or motor roads, and wheeled vehicles cannot be used. Hence goods must be transported on pack animals, which can follow rough trails that require no expense for their construction.

This difference in the means of transportation does even more than the steep grades and the greater distances to make transportation more costly in mountains than in plains. For example, it costs about two cents to carry a ton of freight a mile on a level railroad. To carry a ton the same distance on the backs of horses among the mountains often costs from $1 to $5. It may pay to carry gold long distances by such expensive methods. It rarely pays to carry cheap, heavy articles such as iron. If grain were carried from Illinois to New York by this expensive method it would cost $20 to $30 a bushel.

(*c*) AN EXAMPLE OF THE EFFECT OF MOUNTAIN TRANSPORTATION. Sometimes the difficulty of transportation among the mountains leads to peculiar kinds of lawbreaking. For instance, in inaccessible parts of the Appalachian Mountains "moonshiners" distil whisky illegally. Corn, which is their chief crop, cannot be taken cheaply to the lowland market for lack of good roads. It would not bring a quarter of the cost of transportation. Whisky is only one thirtieth as bulky as the corn from which it is made. The cost of transportation is thus reduced so that the mountaineer can market his product in the lowlands at a profit. This fact has caused the mountaineers to break the law for many generations. When the government collects a tax on whisky, the "moonshiners" feel that it is not right to take away their profit on the only product that they can profitably transport to the lowlands. The ease of hiding a still in the mountain forests, and the rudeness and general lawlessness of the population, are further inducements to moonshining. Thus the difficulty of transportation has long fostered the breaking of the law. The coming of motor vehicles and good roads, however, has largely put an end to this.

(3) *Difficulties of the Farmer in Rugged Regions:* (*a*) RAPID EROSION. The farmer in rugged regions is at a disadvantage because he lives in a region of erosion. Every rain carries away some of the soil, especially when the fields have been freshly plowed. In the Carolinas, Georgia, and other southern states the Appalachian foothills have suffered almost irreparable harm in this way. Under the influence of

unwise cultivation the soil of hundreds of farms has been gullied so that the fields are ruined. In some counties half of the cropland has been washed away. Where the slopes are fairly gentle this difficulty can be overcome by plowing so that all the furrows are horizontal and the rainwater stands in them instead of running down them. This is called *contour* plowing because the furrows run horizontally like the contour lines on a map. In other places the gullies can be checked from spreading further by building little dams at their heads. The planting of grass or small grains such as wheat and oats instead of hoed crops such as corn and potatoes often helps to stop erosion. The washing away of the soil is doubly harmful, for the material carried from the fields is often spread out on the valley floors where for a time it may ruin other fields.

(*b*) THIN ROCKY SOIL. Although more soil is actually formed in mountain regions than in plains, so much is carried away by erosion that the remaining soil is thin and rocky. We have already seen that in the upper Indus Valley among the Himalayas the fields are so rocky that each year, after they have been plowed, women go about picking up the stones and throwing them over their shoulders into baskets strapped to their backs. They have done this for hundreds of years, yet the stones seem to be as numerous as ever. Palestine has hundreds of square miles of bare rock where the soil has been washed away from slopes, and thousands where the soil has become too thin and rocky to give good crops.

(*c*) LACK OF LEVEL SPACES: TERRACES. Another great difficulty of the mountain farmer is the scarcity of level places for fields. He uses the valley bottoms, but to get more land he must construct terraces on the hillside. In China and Japan this has been done on an enormous scale. Whole mountain sides are often covered with terraces, where walls 5 or 10 feet high have been built up in order to form terraces 20 or 30 feet wide. The labor of making such terraces and of keeping them in repair is very great. Moreover, machinery cannot be used in such places. Both these conditions help to keep the mountain people poor.

(4) *Cattle Raising among the Mountains.* Since ordinary farming is so difficult, mountaineers try to make a living in other ways, for instance, by keeping cattle and sheep. These animals can easily graze on slopes too steep for cultivation. They can also be pastured on the rich grass which covers the valley floors and the mountain sides above the treeline. The cool weather causes them to give more and richer milk than in the lowlands. In California in June along the roads leading into the high Sierras, one must often pick his way through herds of hundreds of cows and calves or through flocks of stupid sheep that refuse

to turn out for the passing automobile. The animals are being driven to the high mountains to graze during the summer.

In Switzerland the high meadows, or "alps," have given their name to the world's most famous mountains. Every summer when the snows disappear many people from the valleys move with their herds and flocks to châlets or huts among the flowery meadows near the snowline. There they spend the summer caring for the cows and making butter and cheese. Such a life may be pleasant for a while, but it so lonely and unstimulating that it hampers progress. Nowadays it is declining.

(5) *Tree Crops on Slopes versus Cereals on Plains.* In many respects tree crops are to the mountains what grain crops are to the plains. The world's most important food products are the cereals, including rice, corn, wheat, rye, barley, and oats, but these are not adapted to slopes. Even with good soil, their average value per acre is relatively small compared with such crops as potatoes, tobacco, or oranges. Hence, in order to get a good living, especially if he raises wheat, rye, barley, and oats, each farmer must cultivate a large acreage. He can do this only if he uses machinery. On slopes such machines as gang plows, seeders, mowing machines, and harvesters cannot readily be used.

With trees the situation is different. Although people often forget it, trees furnish not only fruit, but also important food crops such as nuts, olives, berries, and forage seeds. In America this source of wealth is as yet little appreciated, but in the countries around the Mediterranean Sea it is highly important. Many kinds of trees grow quite as well upon hillsides as on plains. The rockiness of the soil makes little difference in their cultivation, for the land does not have to be plowed. Moreover, since there is no plowing, the soil is not washed away so easily as where the crops are planted anew each year. The roots of the trees hold the soil in place, while their leaves increase its depth.

Because of these conditions tree crops are highly profitable in regions of rugged relief. For example, in France and Italy rough, rocky hillsides planted with chestnut trees are often worth much more per acre than our best wheat lands. Walnuts, chestnuts, beechnuts, pecan nuts, filberts, and butternuts all furnish excellent food for man and can be raised on steep slopes. So, too, can the olive, which furnishes the best of vegetable oils.

Acorns, likewise, grow admirably on steep slopes. Although acorns are not a particularly good food for man, the Kurds in Turkey often grind them into flour for bread. For pigs they are excellent. Great herds are fattened on them in the mountains of Yugoslavia. In Spain pigs are also turned into the chestnut orchards to fatten on the nuts that drop while the crop is being harvested. Sometimes the orchards are

located on such steep slopes that farmers dare not turn in the large, fat hogs for fear that they may lose their footing and roll down.

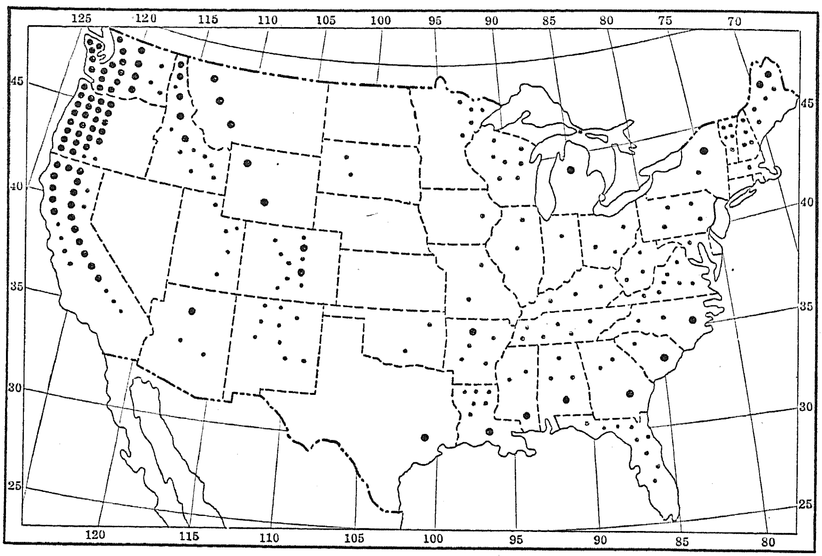
Slopes have a real advantage for orchard fruits, not only because the land is cheap but likewise because they diminish the danger of frost in the spring when the trees are flowering. They also lengthen the season that is warm enough for ripening in the fall, a fact which is especially important for apples, the chief tree crop of the United States. This is because the earth cools off faster at night than does the air. It thereby cools the air that touches it. Since the cool air contracts, it becomes relatively heavy and begins to flow down the slope. Its place is taken by warmer air which has not yet touched the earth. Most people have noticed how this process causes the hollows to be cooler than the land a little farther up the slope on a still summer night.

In tropical countries where there is no frost the slopes often have another great advantage, both for trees and for all sorts of crops. The soil is better there than anywhere else. This is because the soil on the level uplands is often so badly leached that it becomes infertile. In the valley bottoms, on the contrary, the soil is often waterlogged. Where the slope is right, however, the soil is well drained but not too much leached, and hence better than anywhere else. If travelers in places such as Panama knew more about soils and slopes they would not be surprised at seeing fine level grassland used only for cattle, while steep slopes are painstakingly terraced for crops. Nor would they wonder why the coffee of Brazil, the bananas of Uganda, and the crops of many other tropical countries are raised on slopes. Tropical farmers do not understand why the slopes are better, but long experience has taught them that it pays to use slopes and to depend on trees as much as possible.

Lumbering as a Mountain Industry

Trees for lumber as well as for food will always be more abundant in rugged regions than in plains. Many of the plains that are now densely populated were once covered with trees, but today in temperate latitudes forests are largely restricted to rugged areas which cannot be used for farming. Such forest lands are found in northern New England, the Adirondacks, the Appalachians, and the northern parts of Michigan, Wisconsin, and Minnesota. The Ozark region of Arkansas, parts of the Rocky Mountains, and much of the Sierra, Cascade, and Coast Ranges are likewise forested. In Europe the words "forest" and "mountain" are almost synonymous. The terms "Black Forest" and "Black Mountains" are both used for the same part of Germany. Similarly in France the forests have been cut away so fully in all parts except the rugged uplands that a term such as Argonne means both forest and highland.

Until the latter part of the last century lumber and firewood were abundant in the United States because new lowland areas were being cleared for settlement. Now, however, except for some of the sandy pine lands of the South, the main reliance of the country is almost wholly the forests of rugged areas. Even there so many trees have been cut and new growth is so slow that the supply of lumber does not keep pace with the demand. Hence the price of many kinds of wood is five or ten times as much as thirty years ago. This ought to be an advantage to the people of the mountains, but unfortunately for them keen business men of the



A—Stand of Saw-Timber in the United States, 1930. Large dots indicate one per cent of total, small dots one-tenth of one per cent. Total, 1,670 billion board feet. A similar map showing conditions two centuries ago would have *large* dots scattered all over the eastern United States.

cities bought up enormous tracts of forests before the country in general realized their value. (Consult A218.)

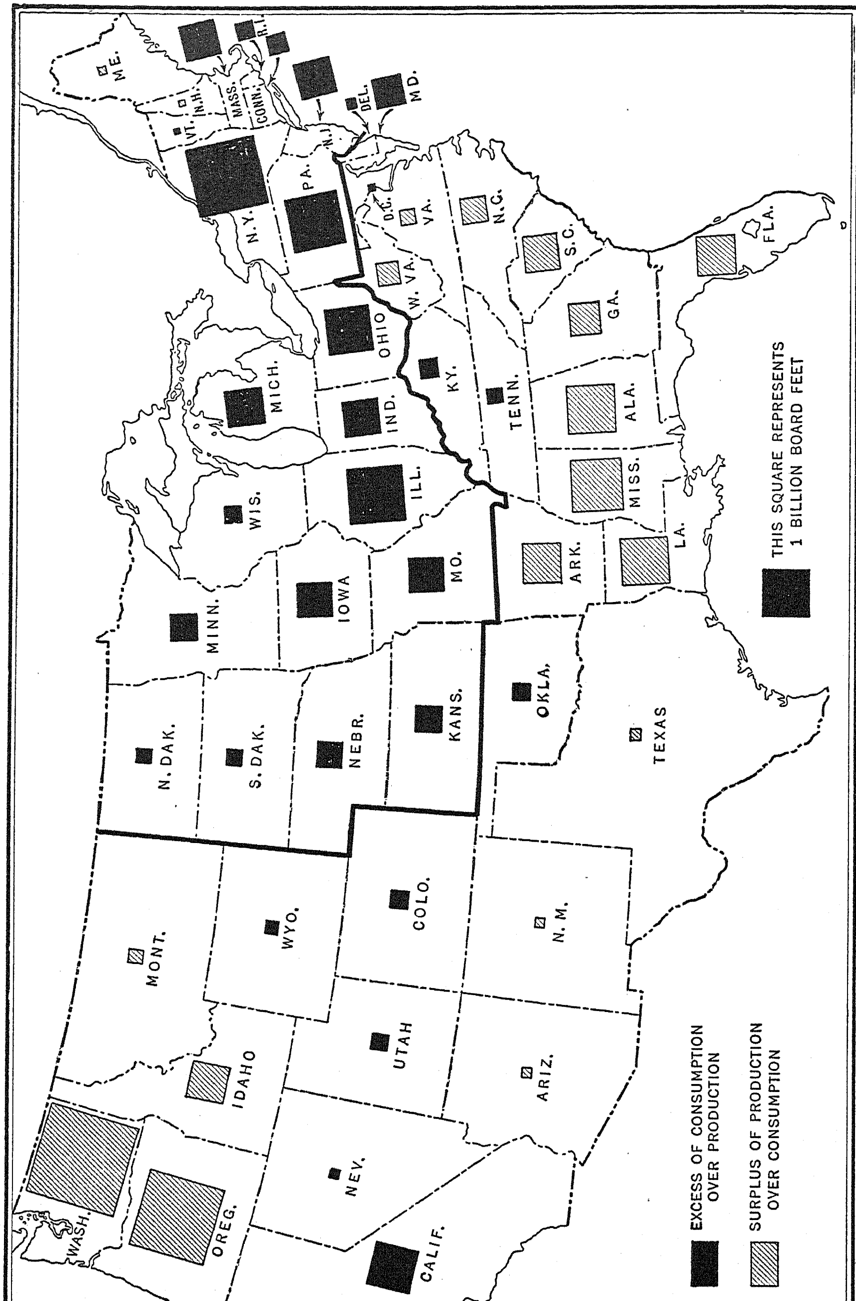
Wasteful Lumbering Methods. In the past the method of lumbering has been very wasteful. The owners of timber tracts have often desired merely to get rich as quickly as possible. Therefore they have sent crews of woodcutters into the forests with orders to cut down everything large enough to be of use. As the large trees fall they crash into the young ones and ruin them. Only the main trunks are used. The branches and the upper third of the trunk are wasted because transportation in forests and especially in rugged regions is so difficult that it does not pay to bring

anything but the best timber out to the plains. When the branches become dry, a stroke of lightning, a match, a lighted cigar, or a camper's fire may start a forest fire that burns hundreds of square miles of timber. This is a terrible disaster, not only because trees are destroyed and people rendered homeless but also because the humus of the soil is burned. In rugged regions the remainder of the soil thus left exposed is likely to be rapidly carried away by the rain. Because of such methods in the past the most populous part of the United States has little timber of its own and is fast using up that of the South and West (A220).

Forest Conservation. Today a new method of lumbering is being introduced. People have begun to realize that without permanent forest reserves we should be put to great stress to find a substitute for wood. Our condition would be like that of North China, where the vast numbers of people, their lack of foresight in cutting the trees, and the dryness of the climate in spring and fall have caused the country to have almost no forests. Wood is there so scarce that many people have difficulty in getting enough for doors, floors, and furniture for their houses, and for the coffins which they buy years before they die. The houses are generally made of adobe, stone, or brick.

In spite of this danger we are still cutting the trees recklessly. Nevertheless the good practices of European countries, such as France and Sweden, are beginning to be adopted under the leadership of the United States Forest Service. The Forest Service believes that the great forests should not merely enrich a few individuals now, but should benefit everyone permanently. Hence they must be owned by the government, but with opportunity for everyone to buy timber at reasonable terms. Accordingly large tracts of rugged land in all parts of the country have been set aside by the national or state governments as forest reserves. Their total area is about 175,000,000 acres, or about the area of all the Atlantic States from Virginia northward, including Pennsylvania. The care of these tracts is planned so that bad trees are eliminated, good ones are planted, and the land is covered with trees of the right sort to maintain a steady supply of lumber. Anyone who chooses may buy standing timber provided he cuts only the larger trees, and fells them so that they do not damage the smaller ones. He must also pile together the branches and useless tops so that there is no risk of devastating fires.

In addition to all this, the Forest Service maintains a corps of forest rangers and fire wardens. High on a mountain top one will often find a warden living all summer in a little house miles from the nearest neighbor. Every day at certain hours he goes to points of vantage and looks out with his field glass in all directions searching for signs of smoke. If he sees anything that suggests a forest fire he telephones to the foresters



A—Lumber Shortages and Surpluses in the United States.

The solid black squares indicate how large a part of the country does not produce enough lumber to supply its own needs. Our greatest industrial and food-producing regions—the area north and east of the heavy line—cut only 20 per cent of the lumber that they use. The remaining 80 per cent must be shipped in, chiefly from the South and West.

who live down in the valley, and a gang of fire fighters at once starts to put out the blaze.

Why Civilization Is More Backward among Mountains Than in Plains

(1) *Scarcity of Good Artisans.* A progressive community must contain not only farmers, lumbermen, and laborers, but also skillful artisans, manufacturers, and professional people. Among the mountains such people find it difficult to make a living. In the plains a carpenter, for example, usually does nothing but carpentry, and hence is highly skilled. Among the mountains, however, there are few people, and they are very scattered. The steepness of the slopes, the cool climate, and the scarcity of good soil keep them poor. Hence little money is spent for new houses or improvements, and the carpenter can find work only a small part of the time. If he is really skillful and ambitious, the chances are that he will move away to the lowlands where there is plenty of work. If he is less skillful or has little energy, he stays in the mountains and perhaps devotes part of his time to running a farm. Thus he excels neither as farmer nor as carpenter. Since he is not a particularly good workman and his neighbors have little money, they employ him only a few days when they are building a house or barn, and do most of the work themselves. This teaches the mountaineers to try all sorts of work, but it results in many poor cabins and shacks.

Blacksmiths, masons, mechanics, plumbers, and other artisans find it still harder to get work among the mountains, and hence are scarcer than carpenters. Therefore the mountaineer has to do almost everything for himself. This makes him versatile and adaptable, but because he must do so many things he rarely learns to do any of them unusually well—"Jack of all trades and master of none." Nor is he likely to work at any one thing so long and skillfully that he invents new ways of doing it. Doing things with new tools and unusually well—better than ever before—is one of the greatest causes of progress.

(2) *Enforced Idleness.* During the winter when there is little farm work, the mountaineers are often idle. The period when cold weather prevents outdoor work is longer in the mountains than in the lowlands. Moreover, at such times the lowlander can often find work not far away in factories, but this is difficult for the mountaineer. He must stay at home to take care of the animals, clear the snow, break out the roads, get firewood, and the like. If he were surrounded by neighbors as closely as is the farmer in the rich lowland it would be much easier to hire a neighbor to help with the chores while he himself goes away and earns money elsewhere. Sometimes this is possible, but if the nearest neighbor

is a mile or two away and the roads are heavy with snow it may be dangerous to leave wife and children alone. Therefore the mountain farmer stays at home in the winter and does little except his routine chores.

Some mountaineers are so energetic, however, that they engage in occupations such as the woodworking of Switzerland and the Black Forest. Since there is plenty of wood around them, the people have taken to carving it into all sorts of toys for children, and also into elaborate patterns such as clock cases and paneling for churches. The women often make lace or embroidery. Carved wood and embroidery, like the moonshine whisky described earlier, represent a high value in a small compass, and hence can easily be transported out of the mountains. The mountaineers really export their skill, their raw material being of little or no value. Even so, the expense of marketing their products leaves the mountaineer a return much smaller than that of the lowlander for equally good work. Moreover, the growth of machine industries deprives the mountaineer of one after another of his opportunities for work. In this respect, as in many others, there is a growing tendency to concentrate work in places where it can be done most cheaply. This gives a great advantage to lowland cities, especially those on great bodies of water.

(3) *Professions.* A large part of the new ideas of a community come from its professional people, its teachers, clergymen, lawyers, doctors, and engineers. Among mountains they are under the same disadvantage as the artisan. The schools and churches are necessarily small, and can pay only meager salaries. The schools are in session only a few months each year, and church services are held only occasionally. Only a few people are within reach of the lawyer and doctor who settle in a mountain valley, and there is little permanent work for the highly trained engineer.

Since the earnings of professional people are small, it is generally necessary to eke them out by engaging in some other occupation part of the time. The teacher may be also a carpenter, the lawyer a blacksmith, and the minister a mason, and all may carry on a little farming. Naturally such men do not have much time for study and the improvement of their minds, or much money to buy the books and make the journeys to conventions that are essential if they are to keep up their professions. Moreover, it is no easy life for a physician, for example, to have to take long rides on horseback in darkness and storm over poor roads or trails, and then be paid barely enough to live on. Unless teachers, ministers, lawyers, and physicians are working largely for the good they can do, those who have spent much time and money in preparing for their professions are unwilling to pass their lives in lonely places where the difficulties are so great and the rewards so few. Hence the mountains lose and the

plains gain. At practically every college attended by students from the southern Appalachian Mountains or the mountains of New York and New England, the number of students who return to the mountainous section is less than the number who came from there.

Characteristics of Mountain People

Why Mountaineers Are Bolder Than Plainsmen. Mountaineers are generally bolder than the people of plains. This is partly because they are strong and healthy, but also because they have many experiences which never come to lowlanders. A mountain boy has no fear of wild animals because he often sees them. He dares to take off his clothes and wade through a cold turbulent stream that would give the city boy a bad fright and make him sick from the chill. The mountaineer is also bold because he frequently undergoes such hardships as tramping a score of miles in a vain search for game, or spending the night alone in the woods when he hunts for stray cattle on the unfenced mountainside.

Again, in backward regions poverty often makes the mountaineer resentful and quarrelsome, and his envy of the richer people of the lowlands may embolden him to try to get a share of their possessions. Hence when times are particularly hard the mountain tribes of Persia and Afghanistan, for example, descend on horseback to raid farms, plunder houses, and drive off cattle. In some regions such raids occur almost every year at harvest time. The lowlanders are so used to them that they build special towers of sun-dried brick to which to run for refuge when raiders are seen. The boldness of mountaineers was illustrated by the Gurkhas from the Himalayas in the World War. More than any other soldiers from India they made daring raids right into and across the German trenches.

Why Feuds Are Common in Mountains. When one man wrongs another in the mountains it is difficult to get redress through the law, because the officials are usually far away in the lowlands. Among cowardly people this might mean that wrongs would go unrighted. Among bold, sturdy mountaineers, however, it leads men to try to right their own wrongs. Thus if a man is murdered, his brothers, sons, and other relatives feel that it is their duty to kill the murderer themselves. If they do so, the relatives of the murderer try in their turn to take vengeance. Thus family feuds arise, which may last for many generations. Sometimes a little quarrel over some trifle arouses people's anger and blows are struck. The quarrel thus started may go on for decades and cause the children, grandchildren, and even the great-grandchildren of the first pair to lie in wait by the roadside to shoot one another. Not many years ago a Kentucky feud led the members of one family to come down to the

courthouse in the lowlands, take a man out of jail with the connivance of the jailer, and shoot him in the public square. Such things would not happen if the isolation of the mountains had not forced people to look out for their own rights.

The very men who are fiercest in carrying on feuds often become some of the strongest and most valuable members of the community when they learn the ways of more advanced communities. Often, indeed, they surpass those whose ancestors have had every advantage for generations. In Scotland in past centuries the Highlanders used to raid the Lowlands most unmercifully. Today the descendants of the raiders are among the most useful and capable people in the British Empire.

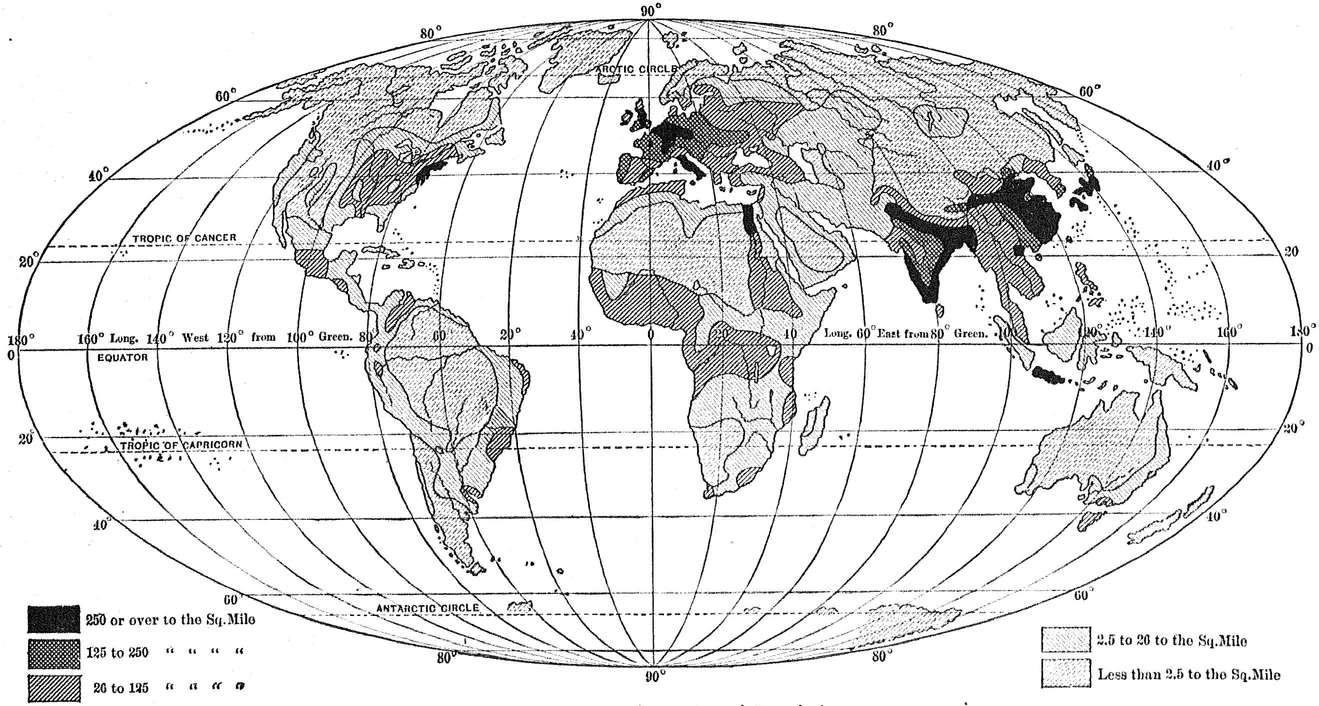
How Mountains Attract the People of Plains

Just as the wealth of the plains has long attracted the people of the mountains, so the scenery and pure air of the mountains now attract the people of the plains. Only the most highly civilized people, however, have learned the value of mountains as places for rest and enjoyment. A century or two ago civilized people such as those of the English and German lowlands regarded mountains as places to be shunned. In old books mountains are often referred to as terrifying, gloomy, frightful. Even today when people first look down a steep mountainside they sometimes feel dizzy. The vast majority of civilized people, however, now regard the mountains as a pleasure ground. Thousands of families escape from the city each summer in order to gain strength and happiness among the mountains. They want to enjoy the wild forests, climb rugged peaks, and feel the exhilaration of the view from a mountain top.

The Alps, White Mountains, Adirondacks, Rockies, and Sierras are full of people who make a large part of their living by taking boarders, running hotels, supplying milk and vegetables, selling small articles made during the winter, acting as guides, and in other ways caring for tourists. In such communities the disadvantages of mountain life are much diminished. Since people no longer depend wholly on local products, their prosperity increases. They can have better schools, better roads, more books, better professional men and artisans, and more advantages in many ways. Contact with people from many lowland regions gives them new ideas, and their life is broadened and deepened.

Local Influence of Slope and Altitude

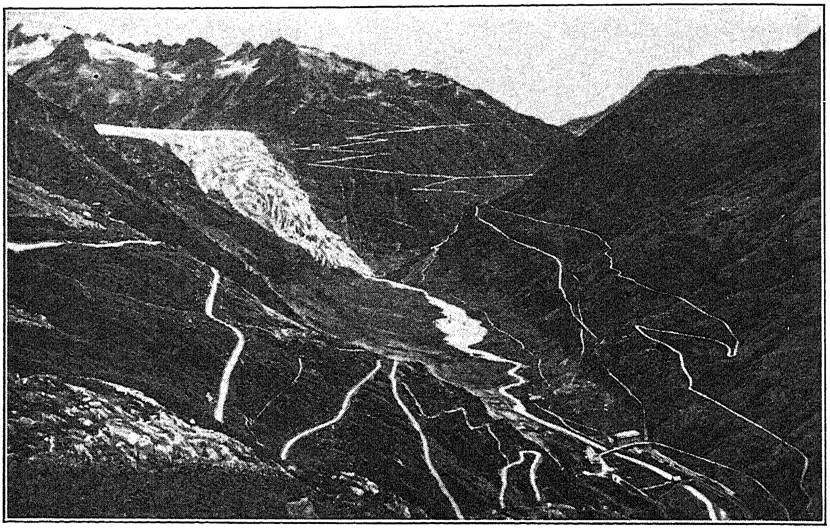
The slope and altitude of the earth's surface influence human activities practically everywhere. Even in the flattest plains the streams run in shallow depressions, and there are hollows where water stands longer



A—World Map of Density of Population.

Note that this is an isopleth map in which lines or isopleths separate areas having more or less than a certain number of people per square mile. The areas having less than 2.5 people per square mile, for example, are lightly shaded, while those on the other side of the 2.5 isopleth are shaded more heavily.

than elsewhere. Railroad and factories are usually located on relatively low land. In mountainous regions, however, the opposite is sometimes true because the railroad often runs along a ridge. The different sections of a town or city can often be classified according to both altitude and slope. As a rule the better houses are located on the higher land. If the hills are high and steep, however, a middle location may be the most desirable, and a band of expensive houses may stand between two sections where the houses are small, as at Scranton. In some towns the steepness of certain slopes makes them undesirable so that they are left unused or



A—A Glaciated Alpine Valley.

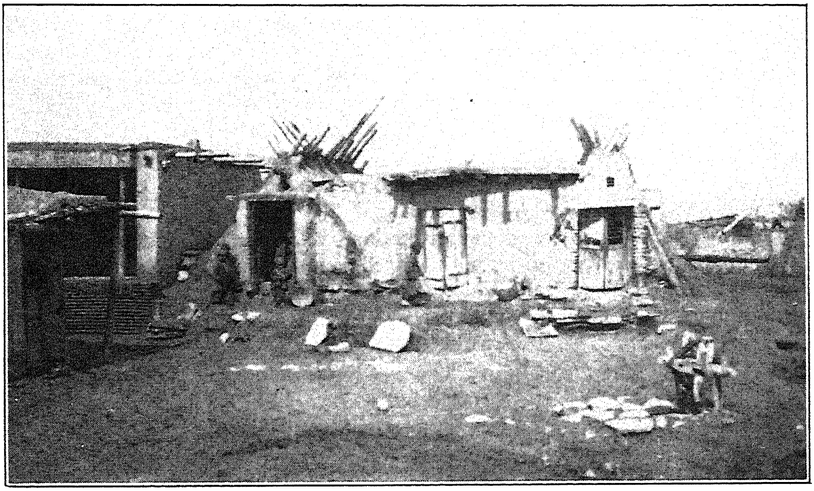
Note the following: (1) the glacier cascading over the valley wall and melting away to form a river down below; (2) the U-shaped, flat-floored valley; (3) the extremely winding roads with shorter, steeper and less winding paths for pedestrians and animals.

are occupied by people with small means. Another effect of relief is often seen in the extent to which the streets depart from straight lines and form a rectangular pattern. In many places certain streets and roads are crowded with traffic, especially with trucks, because they are level, while others are little used because they are steep.

The character of lawns and gardens is much influenced by the slope of the land. Terraces, rock gardens, and in some cases miniature brooks and pools are characteristic of sloping houselots far more than of flat ones. Artistic people sometimes build their houses on pieces of land so high, rough, or steep that other people do not want them. Hilltop sites are often chosen because of their view. In winter the view may have to be

paid for in fuel because of the wind, but compensation for this is found in coolness and freedom from mosquitoes in summer.

On farms the effect of relief is often obvious in the type of occupance. The level land is usually cultivated, or at least devoted to hay. Moderate slopes may be used as pastureland, while steeper slopes remain as woodlots. Again, the slope of the land and its altitude determine the location of the water supply, regardless of whether one lives on a farm or in a city. Maps of the local relief of even a small area become most interesting when they are correlated with human activities.



A—Earthquake Houses in Northeastern Persia.

These were erected after many villages had been destroyed by earthquakes.

QUESTIONS, EXERCISES, AND PROBLEMS

1. A144 and A225 show the distribution of population in two different ways. Which do you prefer, and why? Pick out as many places as possible where the effect of relief, either directly or through climate, is evident in the distribution of population.

2. A226 and A247 illustrate the effect of relief on transportation. Contrast the two in as many ways as possible.

3. On a relief map of the United States study the railroads that cross the Rockies. Which ones follow the valleys? Which ones avoid the valleys and run along the high land between them? Explain why this happens.

4. Select three parts of the world characterized as follows: (*a*) a region of plains, abundant rain, and slow rivers; (*b*) a region of gentle relief and exceedingly low rainfall; (*c*) a region of great relief where the higher mountains are always capped with snow. List the difficulties which confront a railroad engineer in each of these

places. On the map determine how abundant railroads are in the places you have chosen.

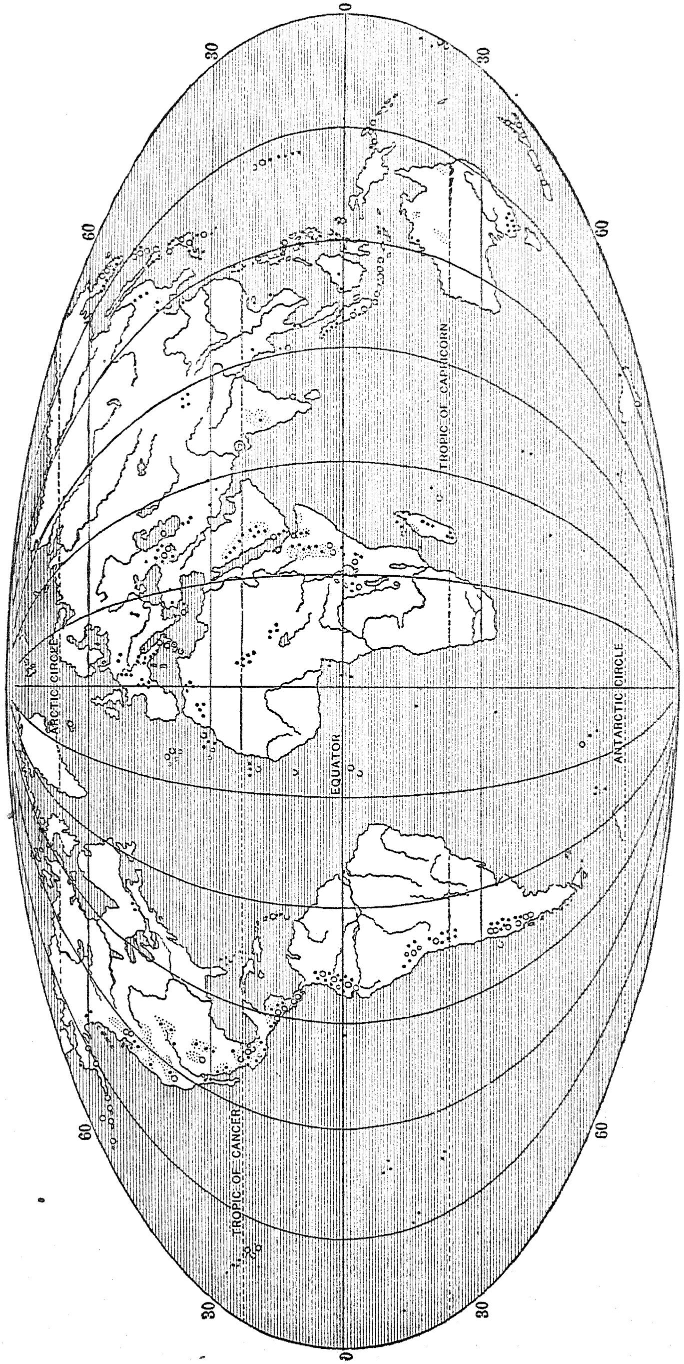
5. Make a diagram to show the relief of your own state. Use the following scheme of shading: (*a*) heavy, for mountainous portions; (*b*) light, regions of low hills; (*c*) no shading, plains. Locate on your map the twenty largest towns of the state. Discuss the relation between the relief and the location of the towns. If your own state does not show marked relief, choose any other in which you are interested.

6. Study the capitals of Europe in relation to the relief. Classify them according to location as follows: (*a*) near the centers of plains; (*b*) on the edges of plains; (*c*) in narrow valleys or among mountains. Explain the reasons for the relative numbers of the different types.

7. A good seaman has been defined as "one who can turn his hand to any task and who can make the best use of any material he may happen to have." Discuss the extent to which this is true of a mountaineer as compared with a plainsman.

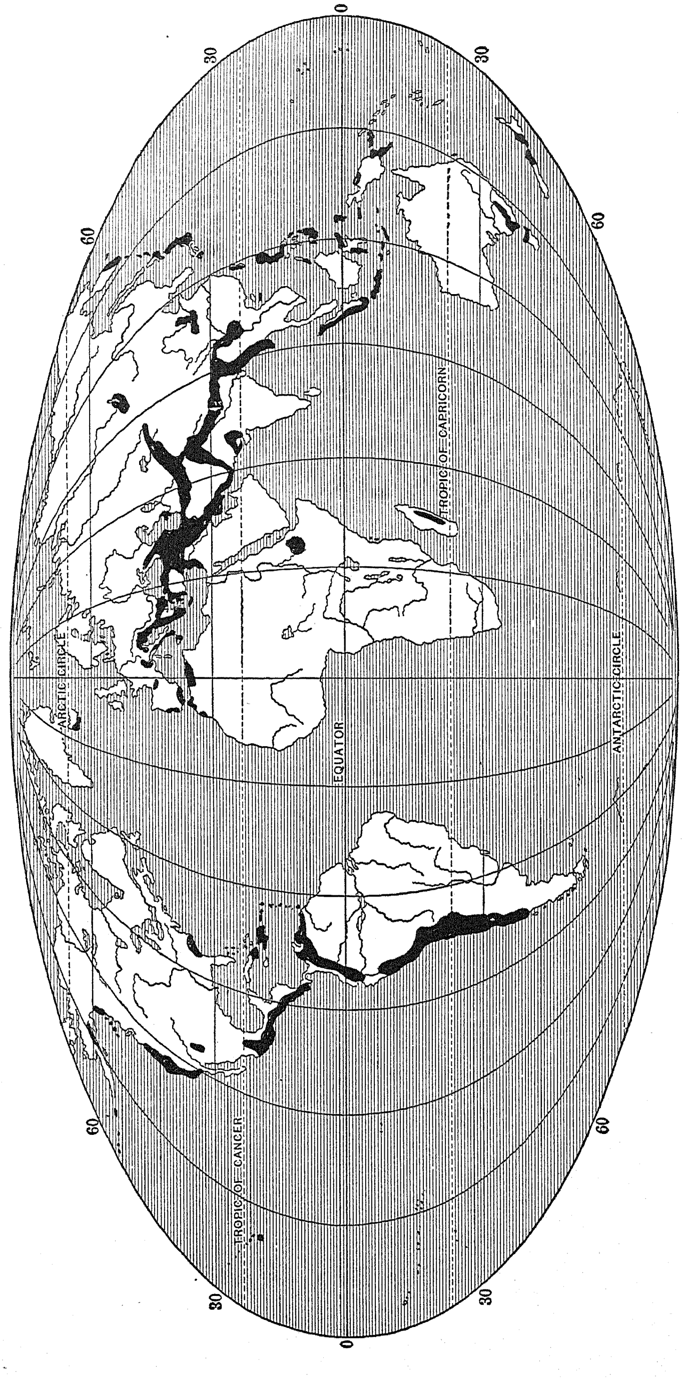
8. A230 and A231 illustrate the distribution of volcanoes and earthquakes. What generalizations do they lead to along each of the following lines: (1) location in respect to oceans; (2) location in respect to young, high mountains; (3) degree of agreement between distribution of volcanoes and earthquakes; (4) countries most likely to suffer from these two types of disasters?

9. Locate A227 in respect to earthquakes and volcanoes. What features of the houses in this picture seem to be well adapted to an earthquake region where the climate is of the relatively dry Mediterranean type with a long, dry, hot summer and a moderate amount of rain from cyclonic storms in winter.



A—Distribution of Volcanoes.—After De Martonne.

Open circles indicate active volcanoes. Dots indicate volcanoes recently extinct. Mollweide Projection. Shaded areas show large deposits of volcanic lavas.



A—Distribution of Earthquakes.—After De Martonne.

CHAPTER XI

THE INFLUENCE OF THE OCEANS

Why Oceans Are Important

Few features of man's geographical surroundings are more important than the division of the earth's surface into continents and oceans. At first thought one might say that only the lands are really necessary. We live on them; their soil yields food for man and beast; they contain mines from which we extract minerals. We travel chiefly upon the lands, traversing the oceans only to reach some other point upon the lands. It would seem that the ocean merely covers three fourths of the earth's surface which might otherwise form fertile plains supporting millions of people. Such a view is wrong, for the oceans are as necessary as the lands. They are of the greatest service climatically as a source of rain and as regulators of temperature. They serve as an aid to health and as a source of minerals and food. Oceans also profoundly influence man's life through transportation, for they act as barriers, and as carriers of commerce. In most respects large lakes act in the same way as oceans.

The Climatic Effect of Oceans

(1) *As a Source of Water for Clouds and Rain.* Even in the heart of a continent much of the rain is derived from the ocean. If crops depended only on moisture evaporated from the lands, including lakes and rivers, most of them would wilt and die. Nebraska and the Dakotas, although in the middle of a continent, raise millions of bushels of wheat by means of water from the Gulf of Mexico or the Atlantic more than 1,000 miles away. Practically all the world's corn crop depends on summer rains from oceans 500 to 1,500 miles away. This is not surprising. Evaporation from land is usually less than from the same area of water, as is evident from the dampness of a sea breeze compared with the dryness of a land breeze. Then, too, the area of the oceans is two and a half times that of the lands, and two hundred times that of all the lakes, rivers, swamps, and other bodies of water on the lands, including the great Caspian Sea. If all the lakes in the world should dry up within a single year they would supply only one-fifteenth of the rain that falls each year on the lands.

(2) *Oceans as Regulators of Temperature.* In addition to supplying moisture the oceans reduce the extremes of heat and cold upon the land. Water requires much more heat to warm it than does land, and is correspondingly slow to cool. Moreover, since water is easily movable the winds give rise to currents which carry warm water from the torrid zone toward the poles and cold water from polar regions toward the equator. Because water heats and cools with difficulty and because the warm and cool parts are mixed by currents, the ocean is warmer than the land in winter and cooler in summer. Hence winds that blow across the oceans are warmed by the water in winter, and cooled in summer. On reaching land they make the summers cooler and the winters warmer than they would otherwise be. How great this effect is may be seen by comparing Seattle, Washington, where west winds from the Pacific Ocean greatly influence the temperature, with Bismarck, North Dakota, which is far from either ocean. In January while the farmers around Seattle are plowing in an *average* temperature of about 40° F. for day and night together, those around Bismarck, where the average is only about 7°, can do little except feed their cattle and protect them from blizzards. In July, on the contrary, the average at Seattle is 64° and at Bismarck 70°. Corn will grow at Bismarck but will not ripen properly at Seattle. If there were no oceans all parts of the United States would have extremes much greater than those of Bismarck; the summers would be unbearably hot and the winters unbearably cold. It is well that the continents are surrounded by great oceans.

The Oceans as an Aid to Health

(1) *The Seacoast Climate.* The coast is the place where the ocean exerts its influence directly upon the greatest number of persons. There the oceans are a wonderful aid to health because extremes of temperature and dryness are rare, while changes of temperature from day to day and hour to hour are frequent. These favorable conditions of temperature, humidity, and variability are brought by winds from the sea. When a land breeze begins to cause extreme heat in summer or extreme cold in winter, a sea breeze as a rule soon arises to moderate the temperature. Almost the only unfavorable effect of the sea upon health in temperate latitudes arises from "hot spells" in summer when the dampness of the sea makes the heat hard to bear. Prostrations and deaths from heat in New York City, for example, are due to this cause, but such occasions are so rare that they are a small matter compared with the benefits derived from being near the sea. Taking the year as a whole, New York City has one of the world's best climates. A place like Newport where the extremes are less pronounced is even better. In practically all parts

of the world the deathrate shows that close to the coast people's health is better than farther inland.

The healthfulness of the coast is one of the main reasons why so many people throng to the seashore in summer. It joins with the opportunities for recreation in causing much of our Atlantic Coast to be lined with summer cottages. It also causes a narrow strip within a few miles of the Pacific Coast to be an uncommonly pleasant place in which to live, and a region of unusual prosperity and progress. Because of west winds from the sea, Los Angeles, for example, averages only 70° during July and August, while Yuma, 150 miles from the coast, averages 90°. In tropical countries the cooling effect of the sea is less conspicuous. Tropical oceans within 10° of the equator usually have a temperature well toward 80° at all seasons. The main exceptions are northern Peru, where the Humboldt Current from the south cools the water, and the mouth of the Congo in Africa, where there is a similar cool current. Nevertheless, tropical seacoasts have a great advantage because the wind is stronger and more steady there than inland. Such winds from the sea temper the constant heat and make people feel like work. They also drive away the mosquitoes and other insects which are a great menace to health and comfort. Hence the people of equatorial Africa, for example, build their palm-thatched huts along the shore in far larger numbers than elsewhere. The white people there appreciate the sea breeze that blows every afternoon so much that they call it the "doctor."

(2) *Seacoasts and Recreation.* (*a*) SUBMERGED COASTS. The variety and beauty of seacoast scenery, and the opportunities for sports such as swimming, sailing, and fishing, join with the climate in attracting visitors and promoting health. In Maine the summer visitor delights in the beauties of a *submerged* coast. Innumerable deep bays dotted with picturesque rocky islands have come into existence because the sea has flooded the valleys. Such conditions tempt one to sail and enjoy their beauty even if he does not care to catch the fish which abound in the cold water. The intervening peninsulas with their garment of spicy pine forests and their rugged cliffs worn by the ever-gnawing waves tempt him to go on long walks, or to sit at the top of some bluff and watch the dashing waves, or catch fish from the rocks. Materials worn from rocky cliffs on the outer part of the peninsulas and capes are carried by currents to the heads of innumerable bays, and there form little beaches where boats can safely be drawn up, and where on sunny days the water may become warm enough to permit bathing.

(*b*) EMERGENT COASTS. Farther south in Florida the fact that the coast has *emerged* gives rise to broad sandy beaches. The surf rolls in magnificently to the pleasure not only of the spectators who sit in the sun on the

beach, but also of the bathers, who can enjoy the warm water for hours each day. Children delight to dig in the dry sand near high-tide level, and watch the pelicans open their enormous bills. Between the levels of high and low tide the damp beach is so hard and smooth that it offers an almost ideal place for automobile races. Many of the world's speed records have been made here. Boating is not so easy as on the submerged coasts farther north, for only where streams enter the ocean can even

A—Mountainous Seacoast. Taormina at the foot of Mt. Aetna in Sicily.

small boats be kept. When the boats get out to the sea, however, such fish as the barracuda and shark afford the finest kind of sport.

A few weeks of ocean air and pleasant recreation on almost any seacoast of the United States at the right season make one feel full of energy and ready for all sorts of work. Part of the benefit is due to the ocean climate and part to the change from home conditions, together with the outdoor life, and the opportunities for new forms of recreation.

(3) *The Ocean as a Purifier.* Another important function of oceans is their help in the expensive work of getting rid of sewage in such a way that it will do no harm. In general the sewage is conducted into some neighboring body of water. If the water is in motion the sewage is carried away and greatly diluted. In a short time the water purifies itself so that even the most careful analysis fails to show pollution. If sewage is conducted into a body of standing water without marked currents, however, the water becomes polluted and may prove a source of grave danger. Chicago found this to her cost when she tried to dump sewage into one part of Lake Michigan and take drinking water from another. She had to spend about 40 million dollars in order to build a drainage canal deep enough so that the dirty Chicago River, into which the sewage pours, would flow toward the Mississippi River instead of toward the lake. On the seacoast, especially where there are strong tides, the difficulties of disposing of sewage are reduced to a minimum. In some coast cities such as Boston, for example, part of the sewage is held in reservoirs until strong outgoing tidal currents have developed. Before the turn of the tide it has been carried so far that it has become mixed with an enormous body of ocean water and has become harmless.

The Ocean as a Storehouse of Minerals

Since 3½ per cent of the weight of sea water consists of solid mineral matter in solution, the ocean serves as a storehouse of minerals. Every stream and river carries a small amount of dissolved material. The water which reaches the sea is eventually evaporated and goes back to the land, but the mineral matter remains. Thus the sea has slowly accumulated a vast amount of common salt, lime, potash, phosphorus, and many other materials. Even gold and silver are included, but in amounts so extremely small that they cannot be recovered at a profit.

(1) *Salts.* The dissolved material that man takes from the water in largest quantities is common salt. On warm, sunny seacoasts where the water is shallow, large ponds are often banked off by dykes. Here the water evaporates until the salt crystallizes. On the shores of the Mediterranean Sea near Smyrna, for example, and on the coasts of Central America and Java, great piles of white salt crystals often form gleaming cones. Most of the world's salt, however, comes from ancient deposits like those at Syracuse and Stassfurt, and was laid down long ago in salt lakes whose waters very slowly dried up in the same way that the water of the enclosed ponds on the seashore now does. In addition to common salt, or sodium chloride, many other salts can be recovered from sea water. The Dupont Company has a ship which sails around without any destination, taking sea water into its hold and extracting bromine.

(2) *Limestone.* Aside from common salt the most valuable mineral in sea water is lime. Shellfish constantly use this for their shells. Some of the shells are thick and heavy like those of clams, oysters, and the great edible abalone of the Pacific Coast. Others are beautifully branched like many corals. Still others are so small and thin that they cannot be seen by the naked eye. Globigerina ooze, a soft mud which covers large areas of the sea floor, consists of such shells. It would form chalk if converted into stone. One or another of these kinds of shells has given rise to vast deposits of limestone. Long ago the sea once encroached far into what is now the continental interior. Hence, large deposits of limestone are found in most parts of the country. Without them we should be at a loss to make cement and concrete, to obtain lime for mortar and plaster, and to find the flux so essential to the smelting of iron, and a fertilizer needed on many soils.

(3) *Potash and Phosphorus.* Certain other valuable materials, although present in quantities too small to be profitably extracted by man, are taken from the sea water by plants and animals. One of these is potash. A large seaweed called kelp contains so much potash that it is gathered by seacoast farmers as a fertilizer. According to the United States Department of Commerce the kelp crop on our Pacific Coast would be worth 100 million dollars per year if it could be economically harvested. Another valuable fertilizer, phosphorus, is taken from sea water by fish. It is found in their bones and scales, and in the guano deposited by birds that live on fish. Millions of tons of guano have been taken from islands off the coast of Peru as fertilizer. It is still accumulating there, for millions of seabirds roost on the islands at night and fly over the sea searching for fish by day. In the morning they go out to sea in vast processions that fly low over the water and take two or three hours to pass.

Fisheries

The presence of vegetation and hence of fish in the waters above the Continental Shelf permits seacoast people to carry on fisheries as well as the ordinary occupations of the land. The word fisheries means the work not only of catching fish, but also of gathering mollusks or shellfish like the oyster and clam, crustaceans like the lobster and crab, and even mammals like the whale and seal. The fisheries of the United States furnish an amount of food equal to nearly half the pork consumed in the country. In countries such as Norway and Japan fish form the most important animal food. This is partly because the deeply indented coasts are favorable to navigation. Even more important is the fact that cool parts of the Continental Shelf, where fish are abundant, offer a better chance to get a living than do the rugged slopes which form a large share

of these countries. In Japan the traveler is surprised by the variety of ways in which fish are served. In addition to the ordinary dishes, he may be offered raw fish with salt and pepper, or a soup made of the water in which fish have been boiled. In our own country fish are used chiefly near the indented coasts of the rugged northeast and northwest, but form an important element of diet in most parts of the country (A116).

Shallow-water Fisheries. Fisheries fall into two classes according to whether they are carried on in shallow waters near the coast, or in deeper waters out in the open sea or on ocean "banks." Many shallow-water fisheries are concerned with shellfish. Clams, for example, are dug in large numbers at low tide on the New England and Middle Atlantic Coasts. The oyster "crop," which may amount to a third of the value of all the fisheries in the country, is dredged from the bottom in water not over 100 feet deep. About five sixths of the world's oysters come from the Atlantic Coast of the United States, especially from Cape Cod to Cape Hatteras. The lobster, which lives in shallow waters, especially on the Atlantic Coast from the Delaware River to the St. Lawrence, is so highly prized that the United States has been obliged to pass stringent laws to conserve the supply: hence our chief supply now comes from Canada.

The Government and the Sea Floor. The animals in the shallow oceanic waters are so valuable and the demand for them so great that the government has been obliged to help in two respects. First, it is trying to increase the supply by protecting the eggs and raising young animals in huge quantities until they are large enough to be set free and shift for themselves. Second, it is setting aside certain parts of the sea floor for a sort of private ownership, so that people may care for the eggs or spawn of the oyster, for example, and see that the young oysters have a chance to grow. This makes it worth while for a man not only to place old oyster shells or tree branches in the water to provide lodging places for the spawn, but also to hatch oysters artificially and place them in beds on the sea bottom. He knows that the government will protect his right to harvest the crop that he has planted. It will punish unscrupulous people who come on a dark night or in a fog to steal the oysters, just as it will punish the thief in a peach orchard.

Salmon Fisheries. The shallow-water fisheries are concerned not only with animals such as oysters and lobsters that spend their lives in one locality at the bottom of the sea, but with genuine fish such as the shad, sardine, herring, and salmon. These fish travel long distances in great shoals to reach their feeding grounds, or to find safe places where they may lay their eggs and the little fish may grow up. By some strange instinct the adult salmon go back to the stream where they were hatched.

If they are prevented from going back to some particular stream, they kill themselves in the attempt, and no more salmon will be found unless the stream is restocked. During the spawning season the lower parts of the rivers that empty into the Pacific Ocean from California around by Alaska to Japan are crowded with salmon. So numerous are the fish that great waterwheels are sometimes arranged so that as the current turns them they throw the fish out into boats. The rest of the fish come crowding on regardless of those that are captured. In order that salmon and sea trout may still reach the upper waters and thus keep the streams well stocked, large sums have been spent on fishways. At each great dam on the Columbia River, for instance, fishways have been built which are somewhat like stairways with sloping steps many feet wide between little waterfalls 2 or 3 feet high up which the fish can easily jump. In the cold rivers of Alaska multitudes of salmon are caught by men who go there every summer from Seattle and other cities. In Alaska the government has had much trouble because "pirate" fishermen put nets across a whole stream. They get a big catch, but there are no fish there the next year. No other fish is so extensively canned.

Deep-sea Fisheries. The deep-sea fisheries are centered in the "banks," or oceanic shallows of three chief regions (A116). One region extends from George's Bank off Cape Cod to the banks of Newfoundland and Labrador. This is the fishing ground in which the United States is chiefly interested, for although fishermen come there from Europe and Canada, the greater part of the catch is made by New Englanders, especially by men from Gloucester, who take their fish to Boston. The most important fish on this shallow part of the Continental Shelf is the cod, which is usually salted and dried. It is shipped to all parts of the world. In the early days of New England the codfish was so important that several times the colonists would almost have starved without it. Therefore it is fitting that a wooden cod should hang over the chair of the President of the Massachusetts Senate.

The second region includes the banks of the North Sea, where the world's greatest fisheries are located. With these may be included the fishing regions off the coasts of Norway near Iceland, Faroe, and other islands. The third region is the Pacific waters near Japan and northward, where thousands of boats scour the seas for the fish that form the main animal food of the 60 million Japanese.

Location of Fishing Communities

Effect of Latitude. The world's chief fishing communities are all located in comparatively northern latitudes. One reason for this is that fish can easily be preserved in cold climates but not in warm. When fish

are caught far from land it is difficult to dry them. The cheapest and in fact until recently the only way to preserve them is to salt them down in the ship's hold. This is successful only in high latitudes, for elsewhere the fish will not keep. The people of the tropics generally catch fish only for immediate consumption. The modern process of cold storage, however, is at last making it possible to catch fish profitably on a large scale in tropical regions, and thus opens up an enormous and almost untouched source of food.

A second reason why fisheries have developed in high latitudes is the coolness of the water and the consequent abundance of food. The number of living animals is perhaps no greater than in warmer waters. The processes of decay, however, are far slower. Hence there is much more chance that a dead creature will float around in the water until it becomes food for a fish instead of being destroyed by bacteria. A third reason for the northern location of fisheries is that deep-sea fishing requires much energy. On the sea, as on the land, the development of new resources waits for the active people of the North.

Fisheries and Submerged Coasts. Most of the world's great fisheries are located near submerged coasts. On such *drowned coasts,* as we have seen, the water has converted the valleys into bays and left the ridges as headlands or islands. In North America such coasts are found along the north Atlantic shore from Virginia to Labrador, and on the Pacific Coast north of San Francisco. In Eurasia they are found around the North Sea and northward to Scandinavia, and in China, Japan, and regions farther north. On submerged shores innumerable little harbors tempt people to keep boats. The island headlands arouse curiosity and lead people on and on. When storms arise an island or a bay usually offers shelter. The land behind the coast is likely to be hilly, so that people are forced to seek the level land along the shore. Thus in such surroundings many conditions combine to make a large portion of the people familiar with the sea. This gives them confidence to undertake short trips within sight of land, and then long adventurous voyages across the ocean.

Fisheries as a School of Seamanship

On such voyages few can succeed except men who have learned the art of bravely enduring difficulties and who have the greatest strength and courage. On the Newfoundland Banks, for example, the fishing fleet, partly steamers and partly schooners, often lies for weeks in the cold fogs. On the Banks the fishermen used to be exposed to the danger of being run down by great ocean liners, for the fishing grounds are near the shortest route from England to America. Icebergs may be run into before they are seen. In the fog the small boats that are sent out to take

the fish from the trawls and rebait the hooks occasionally lose their bearings, and may never be able to get back. Even when the boats are in no danger, the work is miserably wet, cold, and tiresome. Ages of such fishing have bred courageous qualities along the coast of New England, the Canadian maritime provinces, Norway, Great Britain, and Japan. This has greatly helped to give these regions a foremost rank in commerce. In former days the fishing fleets were the school of seamanship, and from them came the men who made it possible for great fleets of merchantmen to be developed. Even in the second World War it was largely the fishing fleet of Britain which made it possible to sweep up the mines laid by the Germans. Only thus was it possible for ships to bring food and the supplies on which the British were absolutely dependent.

Norway furnishes an admirable example of the effect of geographical conditions upon fishing and thus upon commerce. Her abundant harbors, bracing northern climate, and agricultural poverty combine with the energy of her people to cause her to have a merchant marine surpassed only by those of far more populous countries such as Britain and the United States. Italy illustrates the matter in another way. The coasts of Italy are not particularly well supplied with harbors, and the land is fertile. Accordingly, from the days of Cæsar to our own, Italian ships have been largely manned by sailors from the submerged and relatively sterile Dalmatian coast on the other side of the Adriatic Sea. This condition led to a serious quarrel at the end of the first World War. Italy wanted to keep the Dalmatian coast, especially Fiume, because of the little Italian seaports along it, but the other powers thought Yugoslavia ought to have this coast. Since then Italy has taken possession of Albania, and is still eager to extend her power in this region.

Oceans as Barriers

From the earliest times the ocean has been a barrier, but its importance in this respect is steadily decreasing. For thousands of years the Atlantic, the Pacific, and the other oceans were such barriers that people never crossed them. This is one chief reason why the native race of men and the species of animals and plants in Australia are so different from those of the other continents. This is also the reason why the great land mass on one side of the world is called the *Old World,* while the two continents on the other side are the *New.* Not till 1492, save for sporadic visits, did the men of the Old World succeed in crossing the Atlantic barrier to the strange lands of America. They marveled at the Red Men, they found a new grain known as maize, a new vegetable called the potato, a weed which people smoked in pipes, and many other things unknown to them because they had not been able to cross the water.

How effective the ocean barrier may be is illustrated by the life of Napoleon. After he had been conquered by the English, Spanish, and Germans he was sent to the island of Elba as an exile. There, however, the water that separated him from France was so narrow that he escaped from exile and returned to lead his armies once more. Then when he was again conquered at Waterloo in 1815 he was sent to the little island of Saint Helena, separated even from Africa by a barrier of 1,200 miles of water, and from France by 5,000. He could not escape, and so spent the rest of his life there. Like the lighthouse keeper on a rocky island during a storm, he was held in one small place because he had no means of crossing the ocean barrier.

Water as a Defense against Enemies. Water barriers are as effective in keeping people out as in keeping them in. In prehistoric times some of our ancestors protected themselves by building huts of poles and bark on piles in the shallow water near the shore of lakes. The same method is employed at present in New Guinea and other East Indian Islands. A narrow walk leads from the shore across the water to the huts. Part of the walk consists of a plank which can be lifted from the village side. Thus when a community is gathered in its huts with the canoes tied under them and the plank raised, enemies have hard work to approach because of the barrier of water.

The British Isles illustrate the way in which the influence of the geographic environment changes when new inventions are made. Until the airplane was invented Great Britain was almost like a home on piles with the plank drawn up. It lay close to the coast of the most progressive part of Europe and could communicate freely with the rest of the world when it so desired. Yet it was separated by a narrow body of water which checked invaders who approached uninvited, and obliged them to come in ships and first win the mastery of the sea. In primitive times, to be sure, the twenty miles of water between Dover and Calais made England isolated and backward, but later for many centuries they were of almost incalculable value. In the later decades of the last century and the first of the present one, when the other great powers of Europe were spending untold millions in preparing vast armies, England was content with only a small army, and saved her money either to develop the industries of peace or to build warships. She knew that because of the water no large army of invaders could quickly be landed on her coasts, and even if it were landed, it could not easily be kept supplied with provisions, ammunition, and reinforcements. So much did she value her island position that, after a tunnel under the English Channel was actually begun, the project was abandoned. England did not wish to build an easy entrance to her front door and thus perhaps give an enemy the opportunity to bring in an

army. For the sake of safety she proposed to compel those who came to her to come in boats.

When the first World War came in 1914, Germany could do little harm to the island empire, try as she might. Even dirigibles and airplanes wrought only intermittent and local destruction on the English coast and in London. The island as a whole was unaffected. In the end, because England's water boundaries had led her to develop a great navy, she maintained control of the sea, and cut off a large share of Germany's foreign commerce, while she herself was being greatly helped by supplies and ammunition from America and elsewhere. When America was ready to enter the war, British ships carried more than a million of our men overseas.

When the next war began in 1939, however, airplanes had improved so much that Britain's water barriers had lost much of their value. Nothing gave the British so much anxiety as the fear that German fliers would bomb cities and destroy not only ships but also railroad bridges, factories, and the docks which hold ships at the level of high tide. By that time safety against air raids demanded a far greater barrier of water such as the whole Atlantic.

Water Barriers of Japan. Aside from Great Britain many other large islands have the advantage of protection by water. Only Japan, however, has so stimulating a climate and is located so close to a continent that it reaps an advantage similar to that of Britain. Japan, to be sure, has the disadvantage of being far from the center of the land hemisphere and of having no highly advanced neighbors close at hand. On the other hand, her island position has allowed her to develop her civilization without being swamped by the barbarous invaders who have again and again entered China from the bleak deserts of Central Asia. In our day Japan has an effective navy and is acquiring a large merchant marine, so that she follows closely in the footsteps of Great Britain.

Oceans as Carriers of Commerce

(1) *Low Cost of Ocean Transportation.* Although the oceans serve as barriers they also help in transportation, provided people build the right kind of boats. Transportation by water is so cheap that the oceans carry a vast volume of commerce. Let us compare this method with others. The cost of transporting goods by hand sledges across snowy mountains is sometimes as high as $20 per ton for a single mile. That is what it cost, for example, when the Klondike mines on the Yukon were first opened, and supplies had to be carried from southern Alaska. To carry a ton a mile in the air costs a dollar or so, although the rate is fast decreasing. The cost by rail is far lower, being less than two cents in the

more thickly settled parts of the United States. On the oceans this low rate falls still lower—less than a fifth of a cent per mile for a ton.

(2) *The Free Highway.* Transportation costs far less by sea than on land for several reasons. First, since the ocean is a ready-made highway free to all, ocean transportation is not burdened with three classes of expenses that are borne by railroads, buses, and trucks: (*a*) *Construction.* Tracks must be built for trains and hard roads for motor vehicles. These may cost only $20,000 per mile in a smooth plain where wood for tires and stone for ballast and road material are abundant. Generally, however, the cost is nearer $100,000 or $200,000 per mile for a railroad track, including roadbed, stations, sidings, bridges, and so forth. A good four-lane cement road costs nearly as much. Among mountains the cost is much greater. The interest required annually on this expenditure is an important item in the cost of land transportation. (*b*) *Maintenance.* Large sums are paid by railroads to maintain the roadbed in good condition. Since the tracks wear out, they must constantly be watched by track walkers and repaired by section men. Motor roads, too, need constant supervision. (*c*) *Taxes* are another item. Even in good years the New York, New Haven and Hartford Railroad pays taxes amounting to about a quarter of its net operating revenue. Trucks and buses do not pay such heavy taxes as railroads, but other taxpayers have to stand the cost of the roads.

(3) *Small Amount of Power Needed on Waterways.* Another important advantage of transportation by sea is that less power, and hence less coal and oil, are needed by steamers than by trains to do the same work. A person of ordinary strength can push a 40-ton boat away from a wharf, provided wind and tide do not interfere, but he could not start a freight car weighing 40 tons without the aid of some mechanical appliance like a lever. Again, the ocean is absolutely level, while no railroad can be free from grades for more than a limited distance. The grades are expensive because the loads must be lifted. Of course they are not lifted straight up, but the total amount of work is the same as if they were. In proportion to the work that they do, trucks and buses use much more power than trains. Airplanes, of course, use vastly more.

(4) *Small Number of Men Needed on Ships.* Another advantage of water transportation is that a given load requires fewer men on a steamship than on a train. A good-sized freight steamer registered at 12,000 tons can actually carry more than 25,000. Such a ship travels steadily at the rate of perhaps 15 miles an hour, which is quite as fast as a freight train when allowance is made for the time spent in waiting on sidings or in the yards where new trains are made up. If used only for freight, it needs a crew of about 100 men. To carry 25,000 tons of freight on a rail-

road would require about 15 trains of 40 cars each. Each train requires a crew of at least five or six men, and three crews are needed during the twenty-four hours. In addition some attention is required from many station agents, train dispatchers, flagmen, switch tenders, oilers, and others, so that the total amount of work is equal to that of about 30 men for each train, or 450 for the 15 trains. To carry 25,000 tons of freight in 5-ton trucks would require 5,000 trucks. If they traveled 360 miles a day, like the ship and the train, they would need two men apiece. This would mean 10,000 in all, or 100 times as many as the ship.

(5) *Low Cost of Building Ships as Compared with Locomotives.* The cost of building a steamer is less than that of the corresponding trains or trucks. A 12,000-ton freight steamer could be built for $2,000,000. An average locomotive costs $70,000 and a freight car about $3,500, so that a 40-car train would cost about $210,000, and 15 trains about $3,150,000. Even if 5-ton trucks cost only $1,500 apiece, 5,000 of them would cost $7,500,000, or about four times as much as the ship, and they would not last one third as long.

(6) *Safety of Water Transportation.* From the point of view of safety, water transportation has an advantage. The proportion of passengers lost at sea is less than that on land, and in the number of accidental injuries to employees the conditions at sea are still more favorable. Every accident does some damage which somebody has to pay for, so that even in this respect transportation by water costs less than by land. In the same way trucks and buses have relatively more accidents than trains.

The Role of Harbors in Water Transportation

Transportation on the ocean would be as difficult without harbors as railway traffic would be without stations and freight yards. A good modern harbor must furnish (1) *protection* from winds and waves, (2) good *depth* of water in the channels and close to the shore, (3) abundant *anchorage* room, and (4) plenty of *space for wharves or docks*. A harbor may possess all these qualities, however, and yet not lead to the growth of a great city, as may be seen at Mount Desert in Maine and in the many deep bays that border the coast of Labrador. It needs also (5) abundant *level land* for city buildings, (6) easy *lines of communication* with the interior, and far above all else (7) a rich *"hinterland"* or *"back country"* in which to sell imported products in exchange for raw materials, food, and manufactured goods.

(1) *Why Harbors Need Protection.* No matter whether people use primitive canoes or huge modern steamships, navigation is hampered unless the harbors are well protected. Islands and headlands break the force of the waves and winds and thus, by preventing the boats from

being tossed about and perhaps dashed against the shore or against one another, make it easy to load them at all times. So important is protection that millions of dollars are spent annually for breakwaters.

(2) *The Constant Demand for Deeper Harbors.* For small sailing ships, harbors 10 to 20 feet deep are sufficient. So long as such ships were the largest that sailed the ocean it was possible for a port such as Salem, Massachusetts, with only a shallow harbor, to do more business than Boston, and almost as much as New York. Newburyport, Gloucester, Fall River, New Bedford, New London, and many other places were almost equally important. The presence of many small ports made up for the absence of railroads, as long as most of the people lived near the coast. When the steam engine was invented, and still more when iron and steel took the place of wood in building vessels, the size of ships increased greatly.

Large ships are more economical than small ones. A freight steamer costing $500,000 and requiring a crew of 40 men will carry twice as much as two smaller steamers costing $600,000 together and requiring 50 men. Some modern ships have a "tonnage" of more than 70,000 tons and could carry nearly 150,000 tons of freight if they did not give up so much space to passengers. Such a ship is well over 1,000 feet long, 100 feet broad, and 60 feet high from keel to upper deck. She draws 40 feet of water. For such steamers a shallow harbor, no matter how well protected, is useless. Practically no important ports, however, have natural harbors with any such depth. Hence each year millions of dollars are spent by governments in order to deepen harbors, while cities and states also make appropriations for the work. In a decade the United States government has spent as much as $4,000,000 on the improvement of the approaches to Philadelphia alone. New York, San Francisco, and Seattle are the only American seaports having channels deep enough at low tide for great steamers such as the *Queen Elizabeth.* Only at New York, however, can such ships lie at the wharves. With the growing tendency to build large ships the ports with the deeper channels and better harbors are likely to grow more and more at the expense of those with shallower channels.

(3) *The Need for Roomy Harbors.* Deep water is needed not only in the channel but also in places not far from shore where vessels can find room to anchor and turn around. A 1,000-foot vessel needs nearly half a mile of free space in which to turn around, even though she has the help of tugs. When the great *Imperator* first came into New York Harbor the captains of some of the other boats in the North River did not realize how much room she required in order to turn and get into her berth in the dock. Consequently she bumped one or two other ships, ran into a wharf, and did such damage that her landing cost $45,000. Because of

the large area required to maneuver modern steamships a river such as forms the harbor at Savannah is rarely so valuable as a bay along a submerged coast like that of the Atlantic from Norfolk northward, or the Pacific from San Francisco northward.

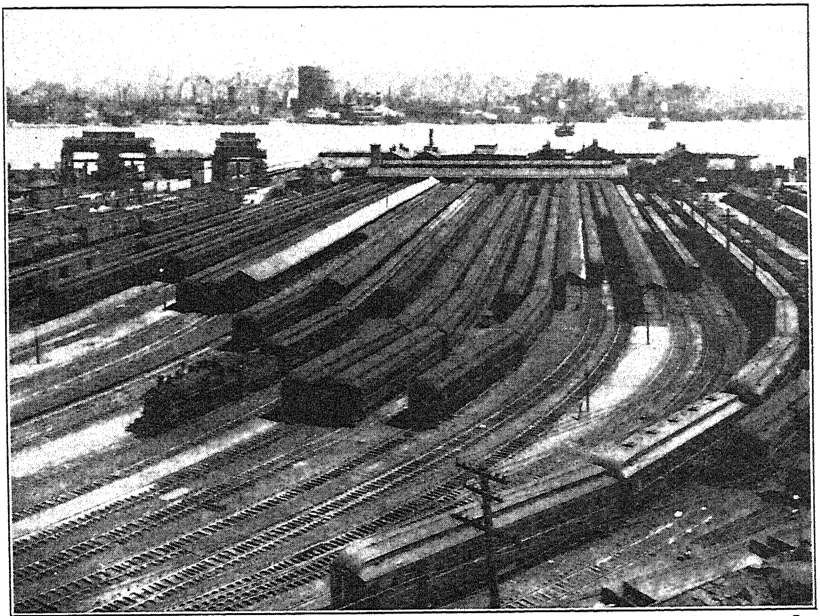
(4) *Dockage Space as a Necessity of a Good Harbor.* Harbors on submerged coasts furnish not only ample room, but also adequate dockage space. Liverpool, for example, on the estuary of the Mersey, where ships can lie close to the shore, has a great advantage over Shanghai, on the Yangtze delta, where many ships discharge their cargo into lighters while at anchor in the river, five miles from the city. In bays formed by submergence the long shoreline and deep water close to the shore enable wharves to be built, so that steamers can be loaded directly from the land. It is an expensive thing when a ship costing a million dollars has to spend two-thirds of its time in port lying idle while waiting to come up to the wharves, as has often happened at the oil port of Batûm; the charges for interest, for depreciation (that is, wear, rust, breakage, and decay) and for obsolescence (getting out of date) count up almost as rapidly as if she were carrying merchandise, while the wages of the crew also continue. Hence shipowners prefer to send their ships to places where abundant docks and wharves make it possible to receive cargoes directly from warehouses or from railroad trains which come alongside, so that their loads may be hoisted from the cars to the ship's hold. Boston is an example of a great port which has suffered from lack of docks in the past, although now this is being remedied. New York, on the other hand, has the most extensive dockage facilities in the world. Counting all the little bays and estuaries New York Harbor has a water frontage of 771 miles, 290 of which have been improved.

(5) *How Land for City Building Affects the Value of a Harbor.* If a harbor does much business it must have a large city beside it. Such a city needs level land, especially for its business sections. Some cities such as San Francisco have grown great in spite of the hills, but those like Philadelphia, which have plenty of level land, are fortunate. So necessary is this that in many places shallow bays have been filled to make artificial land. The best residential section of Boston is the Back Bay, where once the tide ebbed and flowed. It paid Seattle to spend millions of dollars to cut down a steep hill of gravel in the heart of the city. By means of great streams of water squirted against the hill it was washed into the shallow part of the bay. Thus level land was obtained both by cutting down the hill and by filling the bay.

(6) *How Lines of Inland Communication Make or Mar a Harbor.* A modern seaport can become of much importance only when it is served by numerous lines of inland transportation. Along the Pacific Coast,

for example, the twin ports of San Francisco and Oakland are greatly helped because the combined Sacramento and San Joaquin Valleys enable railways easily to reach the interior of California. Northward to the mouth of the Columbia River, on the other hand, no great city would be likely to grow up even if there were a good harbor, because high mountains everywhere hinder communication with the interior.

(7) *How the Hinterland Determines the Trade of a Harbor.* A harbor has little value unless it has plenty of business. Business depends both on the seaport itself and on other places which are tributary to it,



Keystone View Co.

A—Railroad Yards at Weehauken, N. J., Looking across the Hudson to New York. Why is this picture inserted at this point?

or compete with it. The tributary region is called the "hinterland." The importance of a hinterland depends not only on its size, but much more upon the number of inhabitants and their power to produce goods and to buy. Pará is a seaport of minor rank, because its hinterland, the enormous basin of the Amazon, is sparsely populated and undeveloped. Providence, on the other hand, is also a minor port because the more accessible harbors of New York and Boston limit its hinterland to a small area, mainly in Rhode Island. Even such important places as Boston and Philadelphia have much smaller hinterlands and much less trade than they would if the many advantages of New York did not draw trade away

from them. New York's great advantage lies in the fact that it has not only a magnificent harbor, but in addition a superb level route inland up the Hudson and Mohawk Valleys. Moreover, it lies in the very heart of the region where climate, natural resources, and the accidents of historical development bring the activity of America to its highest level.

A limited hinterland hinders the growth of a port even though the harbor is excellent, as is illustrated by the experience of a ship called the *Minnesota*. When she was built, she and her sister ship, the *Dakota*, were the largest vessels flying the American flag. She was put into commission between our Pacific Coast and Oriental ports. Unfortunately, however, she could not at that time get a full load without a long wait. This was so expensive that finally she was transferred to the Atlantic side. The trouble was that on the Pacific side the hinterland contained too few people to supply full cargoes at frequent intervals. The hinterland on the Atlantic side, however, was so much more populous that it easily employed this ship and many others.

The Growth of Seaports

Why Seaports Grow Especially Fast. Seaports are good places for most sorts of business. The people who work on ships and railroads, or who buy, sell, and transfer the goods that pass in and out, have to be taken care of. They provide a market for other people who sell food, clothing, and other necessities. Still others serve as clerks, stenographers, teachers, masons, shoemakers, mechanics, and the other kind of workers who are needed in every large community. Thus a city arises beside the harbor where land transportation meets water transportation.

Such a city, whether it be a port on the ocean like Baltimore, on a lake like Buffalo, or on a river like New Orleans, possesses several advantages. For the manufacturer many kinds of raw materials are cheaper and are found in greater variety there than elsewhere. It is relatively easy for him to build up foreign trade because the representatives of foreign business houses come to seaports much oftener than to cities in the interior. The merchant also prefers a seaport because it puts him in contact with the markets of the world. People who are chiefly interested in art, music, science, or other intellectual pursuits prefer seaports because many travelers arrive, bringing new ideas from other lands. When once a seaport or a port on a lake or river is well started it grows in spite of itself.

Concentration of Population in Seaports of the United States. The remarkable way in which transportation by water influences the size of cities is shown in the following table:

RELATION OF CITIES (METROPOLITAN DISTRICTS) OF THE UNITED STATES TO TRANSPORTATION BY WATER

Size of City, 1930	Number Reached by Transportation on			
	Oceans	Lakes	Rivers and Canals	Land only
1. Over 700,000	7	5	4	0
2. 350,000–700,000 . . .	4	1	4	6
3. 200,000–350,000 . . .	3	1	6	11
4. 100,000–200,000 . . .	8	5	9	20
Total population . .	21,382,000	10,663,000	9,846,000	8,660,000

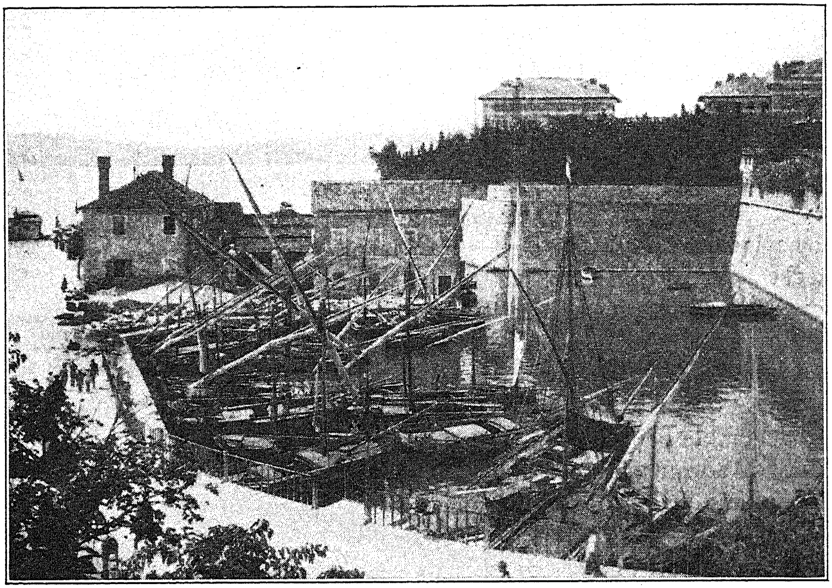
This table shows that all of the sixteen largest cities in the United States, by which we mean what the census calls metropolitan districts, have important means of water transportation. Seven are genuine seaports. Los Angeles, to be sure, made its early growth without the help of navigation, but it felt the need of being a seaport so strongly that it reached out 20 miles and built a harbor at San Pedro. It would never have reached its present size if it had not become a seaport. Five more of these great cities are on the Great Lakes, and the other four on the Mississippi and Ohio rivers. It seems to be difficult, if not impossible, for a city to reach the first rank in the United States unless it is located at a favorable point on some great body of navigable water. Those that have this advantage grow tremendously. The sixteen greatest metropolitan districts of this kind shelter one-fourth of all the people in the United States.

In the second line of the table we see that among cities of 350,000 to 700,000 a third are located beside oceans, lakes, or rivers open to ocean vessels; and nearly a third are on rivers such as the Missouri, Ohio, Potomac, and Connecticut. The remainder are commercial or manufacturing centers such as Atlanta, Birmingham, and Indianapolis, which get no appreciable benefit from water transportation even if they are located on rivers, like Springfield, Mass. But note that even Indianapolis, the largest of the cities located away from such transportation, has only 418,000 people in its metropolitan district, whereas Kansas City and Washington on navigable rivers both have over 600,000.

Among cities of the third and fourth classes in our table the proportion without water transportation rises to approximately half. If the table included the hundreds of small cities with 10,000 to 100,000 people, the proportion without water transportation would be still greater, while

among places having less than 10,000 more than 95 per cent are neither on the coast nor on navigable waterways.

Concentration of Population in Seaports throughout the World. Not only in the United States, but in all parts of the world the demands of commerce usually cause the greatest cities to be located beside the sea. Of the 125 largest cities in the world, 80 can be reached by ocean steamers, and 7 by those plying on the Great Lakes of North America. Even among the remaining 38 interior cities 27 are located on large navigable rivers such as the Mississippi, Danube, Vistula, and Nile, or a few on small navigable



Keystone View Co.

A—A Minor Seaport, Terraferma, on an emergent part of the Italian coast with mountains behind it.

In what respects do you note a contrast between this port and the one in A247? State reasons for the contrast.

rivers of no great importance, such as the Seine, Spree, and Oka, and only 11 are essentially without communication by water.

These facts, like those shown in the table for the United States, indicate that there is a great concentration of large cities on the coast of oceans and great lakes. As time goes on this concentration increases, for it is the logical result of the growth of manufacturing and commerce and of the establishment of closer relations among nations. To accommodate more commerce the seaports must have more docks, longer wharves, bigger ships, deeper channels, and more offices and warehouses. More

railway trains must also pull into the great terminals; broader, straighter motor roads with fewer crossings must be constructed; and airports must be conveniently located in larger numbers. Hence the big seaports and lakeports grow more huge, so that some like New York can scarcely find room for all their buildings.

Oceans and Civilization

Year by year the commerce carried upon the ocean grows more important. The lines of steamship traffic are like arteries and veins which carry life wherever they go. Merchant vessels break down the barrier of the sea and open the seaboard parts of the world to the influence of all the other parts that have harbors. The more the life of the nation depends upon them, the more it becomes essential that they should not be destroyed by calamities such as war.

Before man became civilized the sea and the other great bodies of water played almost no part in his life, except to regulate the rainfall and temperature of the lands, furnish fish for food, and hinder migration. Today the navigable waters are of supreme importance, for they are one of the conditions of the growth of our largest cities; they enable civilization and commerce to spread to all parts of the globe; and their control enables a nation to develop without fear of being overcome by its enemies.

Local Oceanic Geography

The influence of the ocean on the distribution of human activities is very great. Along the shore the heads of the deeper and more protected bays are usually centers of population. There boats lie safely at anchor, wharves jut out from the shore, and a railroad perhaps runs close to them. Back of the wharves lies the business section of the town flanked by factories and surrounded by houses which generally improve in quality as one gets farther from the water. The size of the place depends partly on its hinterland, that is, on the productivity and size of the area which finds this particular seaport the easiest one to reach. It depends also on the depth and size of the harbor, and on the degree to which lines of transportation converge at the head of the bay. A drive of 20 or 30 miles along almost any submerged coast shows illustrations of harbor heads with ports of many sizes from a few houses upward.

On an emergent coast such as that of the South Atlantic States the geographic plan is quite different. Long sandy beaches and sand bars exposed to the full force of the waves make it difficult to use either small boats or great ships. Therefore for long distances the coast is almost uninhabited. Settlements are most likely to be found at places where a

stream of some sort enters the ocean. Such a stream provides shelter for ships and also furnishes an easy route into the interior. The size of the stream has much to do with the size of the port and of the boats or ships that use it as a harbor. Such differences are easily seen within short distances on many seacoasts. Back of sandy beaches and sand bars on both emergent and depressed coasts one often finds lagoons where the water is warm and it is safe for children to swim and for inexperienced people to sail. Frequently the lagoons are replaced by great salt marshes where haycocks stand on stilts in the late summer.

In well-populated and progressive regions the marked variation in the occupance of the seacoast for purposes of recreation and health can usually be seen in a walk of only a few miles on a submerged coast. Exposed rocky headlands alternate with protected beaches at the heads of coves or bays, and the latter are usually the centers of summer resorts. There one finds large hotels, bathing beaches, soft-drink parlors, rooming houses, casinos, and other buildings which carry on the business of a summer colony. Around them small summer cottages stretch in an often unbroken line along the edge of the beach for its whole distance, and sometimes form several rows farther back. Where the beach is broken by a river or estuary, a piece of water protected from the waves may be dotted with sailboats at anchor, while a yacht club may stand close by on the shore. The headlands, on the contrary, are generally occupied by larger houses which are placed somewhat irregularly in more extensive grounds. Their owners often try to keep outsiders away from the shore. The fact that the sea beats directly against steep rocks instead of against a beach helps them in this, but the rocks attract fishermen. The hotels on the rocky headlands tend to be more expensive and exclusive than on the sandy beaches. Few pictures of the geographic environment give rise to such distinct and easily mapped features as do seacoasts with their rocks, beaches, lagoons, salt marshes, river mouths, harbors, and types of human settlements. The rough mapping of a few miles of the coast of any body of water, including the bank of a river, is a most interesting and profitable exercise for a class in geography.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Make a table of forty of the world's great cities as mentioned in Chapters VII, VIII, and IX, beginning with the largest. Opposite each put first the population in thousands as found in some book such as the *Statesman's Year Book* or the *World Almanac,* and then the class of transportation by which the city is reached, i.e., (*a*) ocean transportation, (*b*) lake transportation, (*c*) river or canal transportation, or (*d*) no water transportation. See if the proportions are the same as among the larger group of 125 discussed on a preceding page.

2. Describe the harbor nearest your home, or some other in which you are interested, in respect to seven conditions discussed in this chapter. Point out in which conditions it excels and in which it is deficient. Organize the whole into a problem with this form. Why has (or has not) .... become an important seaport? Let each of the seven conditions take the form of minor problems, such as, How has the growth of .... been helped (or hindered) by the protection which the harbor furnishes to vessels?

3. How does the interior location of Hungary handicap that country?

4. Contrast the January and July temperatures of your home with those of some place in the same latitude but much farther in the interior, or else nearer to the coast. How do you explain these contrasts?

5. What connection have west winds and ocean currents with the fact that farming thrives in Great Britain but is practically impossible in Labrador in the same latitude?

6. If there were no oceans why would it be impossible to carry on farming in the vicinity of interior bodies of water like the Great Lakes?

7. If you had your choice between a visit to an emerged or a submerged coast for a summer vacation which would you choose? Why?

8. Give three advantages that are enjoyed by a city on a coast of submergence that are denied an interior city.

9. State why the New England States are still the great school of sailors in spite of the fact that their fisheries employ fewer men than do those of other sections.

10. Give five reasons why steamships can compete successfully with railroads in carrying freight between New York and San Francisco.

11. In the *World Almanac,* or the *Statistical Yearbook of the League of Nations,* look up the tonnage of the vessels belonging to the chief countries of the world. By using a table of population, find out how much the tonnage amounts to per million inhabitants. On an outline map of the world insert the figures thus obtained and shade the map to show four grades. Contrast the countries in the highest grade with those in the lowest in respect to conditions described in this chapter as promoting ocean commerce.

CHAPTER XII

THE USE OF INLAND WATERS

The most important inland waters comprise lakes, both salt and fresh, rivers, and canals. Like the oceans, these serve as (1) regulators of temperature, (2) sources of moisture, (3) an aid to health, (4) a source of minerals, (5) a source of food, (6) barriers, and (7) carriers of commerce. They also serve as (8) sources of water supply, (9) a source of power, and (10) a means of irrigation, fertilization, and drainage. This last pertains so largely to agriculture that it is deferred to Part IV.

Inland Waters as Regulators of Temperature

As regulators of temperature even the largest lakes are of little importance compared with oceans. Yet the southeastern shores of Lakes Michigan and Erie are great regions for grapes and other fruit because the water, which retains the heat of summer in the fall, warms the northwest winds and prevents early frosts. Also in the spring the lakes retain the low temperature of winter. Thus they keep the winds cool and prevent the fruit trees from flowering too early and being nipped by the frost. In the same way health and vigor in Chicago are much improved because the summer heat is often relieved by cool lake breezes which blow like sea breezes in the afternoon. Even a small lake or a broad river cools the wind slightly in summer and warms it in the autumn, when the water does not grow cold so fast as the land.

Inland Waters as Sources of Atmospheric Moisture

Although the effect of lakes and rivers upon cloudiness and rainfall is small, it is important if the lakes are large enough. At the southern end of the Caspian Sea the northern slopes of the Elburz Mountains, well watered by rain from this great salt lake, form a striking contrast to the barren deserts on either side. The Caspian Sea, however, is so large as to be almost like a part of the ocean, and the high mountains at its southern end would cause rainfall even if it were dry. An inland body of water as large as Lake Michigan receives only a little more rain on its eastern or leeward side than on the windward side. Smaller lakes have practically no effect on rainfall.

Inland Waters as Aids to Health

When it comes to health and recreation, inland waters take high rank, although not so important as the ocean. How high they stand is evident from the way in which summer cottages and camps skirt the shores of lakes, ponds, and rivers all over the United States. The boy who goes to the swimming hole on a hot summer day is illustrating the importance of inland waters in this respect. So, too, is his sister who takes her sewing down by the river to enjoy the cool breeze, and his college cousin who goes to Canada on a canoe trip. Few summer resorts are more famous than those around the Rangeley Lakes at Lakes Champlain, George, and Placid, and along the shores of the upper peninsula of Michigan. The Thousand Isles in the picturesque St. Lawrence River are equally noteworthy, as are Lakes Louise and Tahoe in the western mountains.

Inland Waters as a Source of Minerals

Fresh-water lakes and rivers do not furnish minerals, but other inland bodies of water are a source of medicinal salts, iron ore, peat, salt, and potash. Many springs such as those of Saratoga, N. Y., and Warm Springs, Ga., are full of dissolved minerals which have a most valuable healing quality. Bog iron ore is often deposited at the bottom of swamps. Such swamps of glacial origin abound in the sandy region of southeastern Massachusetts, where they are often used for cranberries. Because of them, that region was the main source of iron ore for the early New England settlers. The first iron foundry in America was established at Lynn in 1643 to smelt the ore from neighboring bogs. Today bog iron ore is of little importance because the deposits are so small. Swamps also furnish peat, which may be called a half-mineralized vegetable product. Most of the world's coal appears to have been formed in ancient swamps which were part of the earth's inland waters.

Salt lakes also furnish rock salt, such as is obtained by leading the water of the Dead Sea into little ponds along the shore and there letting the hot sun evaporate it. Such water also yields rarer minerals, like potash, which is found abundantly in many little lakes in western Nebraska. At Searles Lake in southern California a potash brine is pumped out of a mass of salt that looks like melting ice on which stand pools of pale pink water. Many important salt deposits, such as those deep down in the earth near Syracuse, N. Y., and under Detroit in Michigan, were laid down millions of years ago in salt lakes that were gradually drying up. Stassfurt, a hundred miles southwest of Berlin, is the most famous place of this kind. Its deposits have an area of more than 100 square miles. They are so rich in potash and other rare

chemical elements that they have led to the establishment of large chemical industries.

Inland Waters as Sources of Food

In spite of stories of big fish caught in inland lakes and rivers, the amount of food procured in this way is small unless the fish come in from the sea. This is mainly because inland waters supply barely enough fish to tempt professional fishermen. The fish are caught by amateurs who go fishing only a few times each year. Nevertheless, some of the larger lakes, and especially rivers such as the Penobscot and Columbia, where salmon, shad, and sea trout come in from the ocean, support far more fishermen in proportion to their size than do the seas. These men and those who catch salmon and other fish at the mouths of rivers entering the sea procure two fifths of the whole catch in the United States. In Russia, also, the Volga, Don, and other rivers support extensive fisheries. The most famous of these are the sturgeon fisheries, which produce expensive caviar, as the roe or eggs of this fish is called.

Inland Waters as Barriers

The importance of inland waters as barriers is even greater than that of the oceans. Every person who reads this book has probably been put to inconvenience hundreds of times because of some comparatively slight water barrier. Perhaps it was only a brook to be jumped, or a mud puddle to be gone around. Perhaps it was a river which made it necessary to go several blocks out of the direct route to reach a bridge or ferry. Because of their small size and great number inland waters are more troublesome than the vast water barrier of the ocean. Only rarely, as on the Great Lakes and the Yangtze and Rhine rivers, can one travel far on them in the right direction. Because they are numerous, frequent bridges are necessary along most routes, or else one must keep changing between land transportation and boats.

The Mississippi River as a Great Water Barrier. The Mississippi River illustrates many of the ways in which inland waters serve as barriers. On the map notice how largely this great river forms the boundary between states. This is natural, for the stream is so wide, so deep, and so subject to great floods that it is difficult to cross it in boats, and very difficult to bridge it. Not till 1930 was there any bridge over the main river below Memphis, 500 miles from the mouth, and till 1939 people and trains had to cross by ferry at New Orleans. Even now the lower 1,400 miles of the river is crossed by bridges at only five places.

In order to realize the importance of the Mississippi barrier, consider how many delays it causes. Even where a ferry is close at hand, it is a

slow way of travel. At New Orleans, for instance, until recently, all railroads connecting with the West had to run their trains on to ferryboats. This takes *time*, for the cars have to be shunted back and forth, the ferryboats move slowly, and the landing stage must be raised or lowered with the frequent changes in the level of the river, so that the tracks on the land and on the boat meet exactly. Moreover, the loss of life on the river, the extra effort involved in crossing it, and the long delays all cause *expense*, and so does the building of boats, bridges, and tunnels. Every water barrier is a great consumer of both time and money.

To sum it all up, the chief reason why the Mississippi and other bodies of water are barriers is that they require a *change in the method or the equipment of traveling*. A train must run onto a ferryboat, or must make use of an expensive bridge; the pedestrian must swim, or get a canoe or other boat. The change is what makes the trouble, for when once a boat gets its load of passengers or freight, it is a cheap and easy means of conveyance. The man who keeps a motor boat on the banks of the Mississippi has the means of overcoming the water barrier somewhat as his automobile overcomes distance on the land. Nevertheless, because the water level and the current are so variable, he often has trouble in getting into his boat, or in navigating it.

How Water Barriers Determine the Location of Cities: LONDON. Since bodies of water act as barriers, the places where it is easy to cross them are likely to develop into towns. This is because roads converge at such places, and people are often obliged to stop there. London is a good example. Ten or more centuries ago the two most important parts of England were the southeastern corner (Kent, Surrey, and Sussex) and the region between the lower Thames and the curious square-cornered indentation called "The Wash" (Essex, Suffolk, Cambridge, and Norfolk). They were important partly because they were near the continent of Europe. Still more important was the fact that, being flat, fertile, and relatively warm and sunny, they were the best places for farming, which was then by far the most important occupation.

Inasmuch as these two best sections were separated by the Thames, the silk merchant, for example, who went from Cambridge to Paris, or the pilgrim who was returning from Rome to Norfolk, was obliged to cross the Thames, or else go around its head. The lower reaches of the river were not easy to cross because the stream widens toward the sea and is bordered by marshes. Hence traffic converged at the lowest point where the stream is narrow and the banks are firm, and there London grew up. Its site was where the water barrier could be easily crossed. London Bridge, which is one of the world's most famous structures, was erected in order to make this crossing still easier.

In later times other factors have helped London to become great The city lies at the head of ocean navigation on the Thames, and the Thames estuary faces two other estuaries—those of the Scheldt and the Rhine. In our day the people of London do not think much about the Thames as a barrier. Nevertheless, in spite of fourteen passenger bridges, one ferry, and four tunnels they have to go out of their way to get across the river. These facilities for ordinary traffic, aside from the railways, cost between thirty and forty million dollars, and would cost much more today. The expense of maintaining them and of paying interest on the original investment is about two million dollars a year, and the inconvenience caused by them is far more serious. The Thames is still a costly barrier.

OTHER CITIES. Paris, with its center on the little islands of St. Louis and Le Cité, where the Seine is easily crossed, is another city whose location was originally determined by a river acting as a barrier. The city has grown great because it lies near the center of a rich agricultural region known as the Paris Basin. So prosperous a region needs a city of considerable size as its center, and the natural place for such a center, as we have seen, is on the river. But aside from the islands which help to overcome the water barrier and which at one time served as a stronghold protected by water, there is little reason why the city should be located at one place along the Seine rather than another. In the same way Cairo is located at a point where the Nile begins to divide into the many branches, or distributaries, of its delta. Even in ancient times an important ferry was maintained there, since it was easier to maintain one large ferry than many small ones. Here, too, however, even more than at Paris, the river itself is an important reason for the city's growth, for in the delta the many branches of the Nile furnish a network of water routes focusing at Cairo. Chicago's growth in the first favorable location west of the southern end of Lake Michigan is due to the fact that the lake is a barrier as well as a waterway. All the traffic from the North Atlantic States to Wisconsin, Minnesota, and the Dakotas must converge at the lake's southern end. Hence a great railroad center had to grow up there.

THE EXPENSE OF NEW YORK CITY'S WATER BARRIERS. The city of New York, unlike London and Paris, owes its location not so much to water barriers as to the excellent water communication with which it is provided. The very water which affords such good means of communication with Europe and other far-away places, however, is very troublesome as a hindrance to local communication. This is because New York is built on *islands*. Manhattan Island, Long Island, and Staten Island contain four fifths of New York's population. While

the city was small the so-called "rivers" which separate the islands and the mainland caused little trouble, for few people made journeys out of town. In time, however, the lower end of Manhattan became thickly covered with buildings. As this went on, the price of land kept rising. People who were planning new business enterprises did not want to locate beyond the water barriers, but were willing to pay high prices for land near the center of the city. Accordingly, today in some parts of New York a single square foot of land is worth over $1,000. A piece the size of an ordinary school desk is worth about $5,000. From the mere rent of an area the size of five desks the owner could get much more than the average wages of a laborer, or enough to support a family in moderate comfort.

When land became so valuable people began to try to overcome the difficulty due to the water barriers by erecting higher and higher buildings. New York has 36 buildings more than 500 feet high, Chicago has 9, all the rest of the United States 10, and the rest of the world only 2. New York's tallest skyscraper, the Empire State Building with 86 stories, towers a quarter of a mile. Some skyscrapers accommodate 15,000 workers. The streets between such huge buildings are like deep canyons, so gloomy that rents in their lower stories have decreased. When the elevators cease to run, as has sometimes happened during a strike, some of the workers take half an hour to climb to their offices, and a few are unable to do it.

While the skyscraper type of architecture was being developed as one response to water barriers, ferries were coming into existence as another response. Thus large numbers of New York workers were able to build homes in Brooklyn, or on the Jersey side of the Hudson, where land is relatively cheap and the surroundings pleasant. On this account the ferry system grew to such proportions that there are still about 30 lines, although new bridges and tunnels have caused some to be given up. All the railroads, too, except those now known as the New York Central, and the New York, New Haven and Hartford, had to carry their passengers and freight to the city by boat, and some still do so.

In addition to all this the New Yorkers, in their desire to overcome the water barriers of their island home, have built 7 huge bridges to Long Island at the enormous expense of well over $200,000,000. They have spent more than half as much on the still vaster George Washington Bridge across the Hudson from Manhattan to New Jersey, and on 6 smaller bridges connecting the mainland with Manhattan and Staten Island. They have also dug tunnels to carry electric trains under the rivers, 9 under the East River to Long Island, 4 under the broad Hudson to the Jersey side, and 3 under the narrow Harlem River to reach the

mainland on the east. Some of these tunnels are double. In addition to all this, two great tubular tunnels for vehicles have been driven under the Hudson to New Jersey. If the ferries, bridges, and tunnels by which New York overcomes the water barriers had to be built anew, they would probably cost well toward two billion dollars. Even as it is, the yearly interest and cost of maintenance for these facilities amount to $12 to $15 for every man, woman, and child in the city. Although New York harbor is one of the chief causes of the city's greatness, the water separating the different parts of the city is a most expensive hindrance.

San Francisco and the combined city of Norfolk, Portsmouth, and Newport News in Virginia are other cities where water barriers involve great cost and inconvenience. San Francisco is connected with Oakland on the east and the towns to the north by two of the world's most magnificent bridges. The deck of the Golden Gate Bridge, the one to the north, is 200 feet above the water.

Inland Waterways as Carriers of Commerce

Inland waterways, including rivers, canals, and lakes, are especially important as carriers of commerce in backward countries. China, Siberia, and northern Brazil, for example, possess large rivers, but their railway systems are not highly developed. Rivers are also important in advanced countries such as Holland and Germany, where they flow through densely populated plains. Nevertheless, in view of the cheapness of water transportation, the use of inland waterways is by no means so great as would be expected. This is because a single body of water is rarely satisfactory in each of the qualities discussed in the following paragraphs.

(1) *Depth and Breadth.* These two qualities are closely connected. In rivers both of them depend largely on volume of flow. If a river comes from a region of heavy rainfall, it is likely to have great volume and hence to be deep enough and broad enough for important traffic. The Amazon is such a river. For a distance of 2,300 miles its vast volume gives it an average depth of 120 feet and a width of 1 to 6 miles. So huge is the river that while still beyond sight of land sailors sometimes let down buckets and draw up fresh water from what seems to be the ocean, but is really the enormously wide mouth of the river. Cases have actually been known where sailors, not knowing the facts, have died of thirst when adrift on the fresh water at the mouth of the Amazon.

The Rio Grande illustrates the opposite condition. Although half as long as the Amazon, it is practically unused for navigation. The rainfall of its basin is so sparse that it has little volume and slight depth. Even at its mouth it is shallow, and higher up it sometimes runs dry. On most

rivers the presence of sandbars at the mouth and of shallow places higher up is one of the chief hindrances to navigation.

(2) *Navigable Length.* The length of the navigable stretches on a river is of the first importance. The Yangtze, for example, is navigable for 1,000 miles in one continuous stretch from its mouth far into the heart of China. This makes it of great value for commerce. The Orange River, on the contrary, although 1,300 miles long, is of little value for navigation. The stretches where boats can ply extend only a few score miles. Transshipment is so expensive that it would never pay to ship goods 50 miles by boat, then 30 by rail, again 100 by boat, once more by rail, and so on. With some kinds of freight it actually costs more to load goods onto a steamer and take them off again than to carry them all the way from New York to Liverpool. Even under the best conditions a single loading costs as much as scores of miles of transportation. Hence a waterway is valuable for commerce only if its navigable portions are long and uninterrupted.

(3) *Character of Course.* Straight rivers like the Amazon, Hudson, and St. Lawrence are far the best for navigation. On winding rivers not only are distances much increased, but also the channel is almost sure to wind still more, so that little speed can be made, and there is danger of running aground. The extremely winding Mississippi meanders so much that after flowing 10 or 15 miles around a horseshoe curve the stream sometimes comes back to within a few hundred yards of its earlier position.

(4) *Current.* The more gentle the current of a river the better it is for navigation. The great Volga River, even at its source, is only 665 feet above sealevel, while 1,500 miles from its mouth it is only 190 feet above the level of the ocean and 280 above the Caspian. Hence throughout most of its course it flows so gently that ships are little impeded and locks and dams are unnecessary. Contrast the Volga with the Brahmaputra, which rises 15,000 feet above the sea and flows so swiftly over rapids and falls that along much of its course no one has ever used a boat. The Zambezi is another great river along which numerous rapids, in addition to the great Victoria Falls, divide the navigable water into sections too short to be of much use. The other great African rivers suffer the same disadvantage. Even the Nile, which has 2,900 miles of uninterrupted navigation at high water, is at most seasons broken into many sections by rapids, or cataracts, as they are called.

(5) *Seasonal Changes.* Practically every river is subject to strong seasonal changes. Floods and droughts are more or less universal, and freezing is common. The rivers most free from floods come from great lakes, as does the St. Lawrence, or receive an abundant supply of rain at

all seasons, like the two greatest equatorial rivers, the Amazon and Congo. The rivers of Siberia have the disadvantage not only of floods, but also of ice. In the winter the Amur, for example, is frozen for six months; then when the ice breaks up, great floods occur and would wash away not only the shipping, but even the floating docks, which are the only kind possible, if these were not all safely moored in harbors of refuge. Later, however, in May and June, the floods make navigation easy, since the shallows are deep and the rapids smooth. Finally, in the fall before the river freezes up, it falls so low that ships frequently run aground. The Ob, Irtysh, and Yenesei have even worse handicaps than the Amur. They are frozen half the year, and because they flow north, the ice and snow of their upper portions melt while the lower portions are still frozen solid. Hence the floodwaters from above cannot escape down the channel and spread in vast floods over thousands of square miles. In America the Yukon resembles the Amur, and the Mackenzie resembles the Ob and Yenesei.

(6) *Hinterland*. No matter how good an inland waterway may be in other respects, it does not carry much commerce unless a well-populated hinterland supplies raw materials, food, or manufactured goods in exchange for products brought from afar. Compare the Danube and the Yukon. The Danube flows through some of the most densely populated and progressive parts of the world. Hence it carries thousands of boats of all sizes from small ocean steamers and large canal barges down to rowboats. So far as natural advantages for navigation are concerned, the Yukon is little inferior to the Danube except for the long frozen period from October to April. Nevertheless, it does not carry one boat for a hundred on the Danube. Its hinterland contains only a few miners who neither consume much nor furnish any articles of export in quantities large enough to supply cargoes.

(7) *Direction*. The direction in which an inland waterway extends is an important feature which man cannot control. He can deepen and broaden a river, increase the navigable length, and overcome falls and rapids by building canals and locks. He can straighten windings, control the current, overcome the effects of seasonal changes, and populate the hinterland, but he cannot change the general direction in which a river flows. Yet this condition is vital in determining the value of an inland waterway. The Rhine is a relatively small river. Nevertheless, from parts of Switzerland, Germany, and France which are rich in lumber, coal, iron ore, and manufactures, it flows toward the great market represented by the German manufacturing center around Essen and the great cities of Rotterdam, Amsterdam, Brussels and London. Therefore, it supports an incredibly active commerce. The Mackenzie and the Ob are far larger

than the Rhine, but in a year they carry no more commerce than the Rhine does in a day, for they flow toward the frozen north.

Examples of Great Inland Waterways

(1) *The St. Lawrence and the Great Lakes.* Let us now see how far a few of the world's great inland waterways meet the seven requirements mentioned above. The St. Lawrence River and the Great Lakes furnish a broad, deep, and relatively straight waterway penetrating about 1,700 miles into the interior. The Lachine Rapids above Montreal, the falls at Niagara, and the Sault Sainte Marie at the lower end of Lake Superior, to be sure, present some difficulties. Nevertheless, these have been partly overcome by canals and locks so that ships drawing 14 feet can go from the sea to Chicago or Duluth. Another and a more serious difficulty is that, although seasonal changes have no great effect upon the depth of the water, ice closes the St. Lawrence River and the Great Lakes for three months. Such difficulties, however, are much more than outweighed by the wonderful hinterland which includes the rich farmlands of the Corn Belt, the unexcelled iron deposits near Lake Superior, the immense coal mines of Pennsylvania, and the busy manufacturing region from Buffalo to Milwaukee. Thus the Great Lakes portion of the waterway extends in just the right direction to connect regions of four great types producing food, raw materials, fuels, and manufactured goods.

Down the St. Lawrence the direction is also excellent so far as relations with Europe are concerned. It would be better, however, if the river flowed to New York and the great markets on the Atlantic Coast instead of to the barren coasts of Labrador and Quebec. That is why the New York State Barge Canal has been dug 362 miles from Buffalo to the Hudson River near Troy. This canal, however, is only 12 feet deep, so that ordinary lake and ocean steamers cannot enter it, and transshipment is necessary at each end. Hence it carries only 5 or 6 per cent as much freight as the Sault Saint Marie Canal. In 1920 the tonnage carried by the canals of New York State was only about a fourth as great as in 1880, but in 1939 the old level had again been reached.

The further development of the St. Lawrence waterway presents a difficult political problem. This is partly because the upper part of the river belongs jointly to the United States and Canada. It is also because the people of both countries are divided in their wishes. The Canadians west of Montreal and most of the Americans west of Buffalo want to build dams, canals, and locks of such size that ocean vessels can sail directly to any part of the Great Lakes. They say that the water power thus developed along the rapids of the St. Lawrence will go far toward paying for the whole project. On the other hand, powerful business interests in

New York City and to some extent in Buffalo and Montreal are strongly opposed to such a waterway. They think that it would cause vast amounts of wheat, iron ore, meat, dairy products, coal, automobiles, and other products to go directly to Europe from Duluth, Chicago, Milwaukee, Detroit, Cleveland, and other points. This would be good for Europe and the Great Lakes region, but it would diminish the transshipment business of Buffalo, Montreal, and New York.

(2) *Excellent Waterway of the Rhine and German Canals.* The system of inland waterways of which the Rhine is the main artery owes its importance to its hinterland and its direction. Because the Rhine flows through an extremely populous and progressive region and toward the center of the world's activities, the Germans and Dutch have found it worth while to deepen and broaden it; to increase its navigable length by canalizing certain parts; to straighten out the windings; to provide cables to pull ships up through the strongest currents; and to make provision for the regulation of floods. To take further advantage of this excellent waterway, the Germans have built many canals to connect the Rhine with the Weser, Elbe, and other rivers farther east. The canals greatly enlarge the hinterland, and enable traffic to move east and west as well as more nearly north and south along the line of the main rivers. Thus goods from the Vistula River can be carried to Holland by inland waterways without breaking bulk. The Rhine and the German canals well illustrate the tendency of commerce to aim straight at the most thickly settled industrial regions.

(3) *The Superior Inland Waterway of the Yangtze.* The Yangtze River fulfills the conditions of a good waterway to a remarkable degree. It is so broad and deep that even without artificial improvement ocean steamers of 6,000 tons can usually reach Hankow, about 700 miles from the coast. In this stretch the windings are not particularly troublesome, and the current is negligible, for the river falls only an inch per mile. Although floods raise the river 40 or 50 feet at Hankow, they do not seriously hinder traffic. In fact, for these 700 miles, the advantages for navigation are little inferior to those of the Amazon, while the hinterland is far superior. Above Hankow small steamers can go another 300 miles to Ichang, where the river is still only 130 feet above sealevel. Then rapids intervene for 350 miles. Modern boats can indeed steam up them except at low water, but they are troublesome. Nevertheless, so large is the river, so excellent its direction, and so rich and populous the Szechuan hinterland that for hundreds of years Chinese coolies on the river bank have laboriously dragged junks up the rapids. The stream is again easily navigable, higher up.

Everywhere for nearly 2,000 miles the Yangtze flows through a region full of industrious people. Hence its hinterland would be one of the best if only the people were not so poor. It contains more people than the entire western hemisphere. If ever these should become as productive and prosperous as those in the Rhine and St. Lawrence hinterlands, ships might pass as frequently as at the Straits of Dover. The direction of the Yangtze is ideal, for the river runs through the heart of the most fertile part of China directly toward the part of the coast where the greatest cities are located and where trade is most active. The importance of the stream is increased by large navigable tributaries, the chief of which join the main stream near Hankow, and by the Grand Canal, which connects the mouth of the river with Tientsin and the great cities of the Hwang Valley. Contrast this with the slight navigation of the Indus because of its shallow channel and swift course, and because it flows out of huge mountains into a desert.

(4) *An Appraisal of the Mississippi Waterway.* In proportion to its size and length the Mississippi River is used far less than the St. Lawrence, Rhine, and Yangtze. In fact, the tonnage carried by the Mississippi is less than that of far smaller rivers such as the Elbe. This is surprising in view of the many advantages of the river. The channel has a depth of 9 feet to St. Louis, 1,270 miles from the mouth, whereas the Rhine has an equal depth only a quarter as far, to Mainz. The length of the Mississippi is a wonderful advantage; with the Missouri, it is the longest river in the world. The current, though rapid in places, is also comparatively favorable, for below St. Louis the river falls only 4 inches a mile and the heavier traffic is downstream. Finally, the hinterland includes the most fertile parts of the United States.

Against these advantages stand several disadvantages. Two of these are a very winding lower course and seasonal floods, both of which are being overcome, although at great expense. A major disadvantage, however, still remains in the insurmountable drawback that the river lies at right angles to the main lines of traffic and does not flow toward the eastern manufacturing districts and Europe, which are the great markets for the food and raw materials of its rich hinterland. If it flowed from St. Louis to Baltimore or Philadelphia, it could carry the food and raw materials of its rich hinterland toward the great markets of the eastern manufacturing district and Europe. Thus it might carry far more freight than any other inland waterway. As the trade of the United States with South America and the Orient by way of the Panama Canal increases, the value of the great river as an artery of traffic will also increase, but it does not yet show much evidence of rivaling the Rhine, St. Lawrence, or Yangtze.

The Value of a Large Water Supply

As people become more civilized, there is a steadily growing need of a large water supply for three main uses: (1) domestic; (2) municipal; and (3) industrial. Among the domestic uses drinking-water demands an average of about half a gallon per person each day. Cooking requires more, while washing and bathing demand many gallons. To this must be added the water drunk by domestic animals, and that which is used for watering plants, gardens and lawns.

The municipal uses include fire protection, public fountains and drinking places, street sprinkling, and the flushing of sewers. This amount varies from nothing in small villages to many gallons per person in large cities. In the same way the water used for industrial purposes varies from nothing up to a quantity much larger than for the domestic and municipal purposes combined. It includes the water used for engine boilers, for condensing steam, and for many special industrial purposes like washing cloth and cleansing hides.

For all these purposes together, an ordinary American city requires 50 to 150 gallons of water per day for each person. In New York the borough of Manhattan uses close to 200, but the residential borough of Queens uses only one third as much. Water is usually obtained so easily, by simply turning a faucet, that people do not realize its importance unless there is a drought, such as occurred in New England in 1911, or in a large part of the interior of the United States in 1934 and 1939. Then the lawns turn brown, baths have to be restricted, factories are shut down, hundreds of thousands of acres of crops dry up, cattle die of thirst, and farmers have to abandon their homes.

What Kind of Water Supply Is Needed

The quality of a water supply is as important as its quantity. Every up-to-date city employs skilled engineers not only to determine the best sources of water and the best means of protection against contamination, but also to construct purifying works if necessary and to test the water continually for harmful impurities. The requisites of a good water supply are as follows:

(1) *Freedom from Mud.* Mud is a comparatively common evil, but does little harm. The people of St. Louis, for example, drink the muddy water of the Mississippi River. Now they filter it, but even before they had their great filtration plants, they found it wholesome. A little mud is harmful chiefly because it does not look attractive. This is the main reason why cities build settling basins where the water stands for hours and drops its load of silt. Sometimes, however, even a prolonged period of

quiet will not cause the finest clay to settle, and some of the most wholesome water supplies are a little cloudy.

(2) *Freedom from Taste and Smell.* Water that has a disagreeable taste or especially a distinct smell is undesirable. Often, however, what people call a disagreeable taste means merely a taste different from that to which they are accustomed. A smell, however, is likely to be a sign that something is really wrong. Yet neither taste nor smell necessarily indicates that the water is unwholesome, as many people in prairie towns are well aware. Nevertheless, since both are disagreeable, and since either may indicate that the water is bad, cities go to great expense in order to get rid of them, either by filtration or by chemical treatment.

(3) *Freedom from Chemical Impurities.* Some chemical impurities reveal themselves by their taste or smell. A large number, however, such as the lime which causes hardness, do not make the water disagreeable, while some—such as iron—which produce both taste and smell, are beneficial. Lime is by far the most harmful of the common chemical impurities of water and the hardest to get rid of. When hard water is used in boilers it causes the deposition of a limy cake on the inside of the boiler and soon ruins it. In the same way, in man's body, it may increase the susceptibility to rheumatism, goiter, gallstones, and other diseases. When hard water is used for washing it does not form a good lather, and special kinds of more expensive soap are needed. Yet such water may be sparkling and clear, without odor, and with an excellent taste.

(4) *Freedom from Bacteria.* This is by far the most important quality of a water supply. Water that is ideal in other respects may contain the germs of typhoid fever, dysentery, and other diseases. The city of Niagara Falls formerly suffered greatly from typhoid because Buffalo discharges its sewage into Lake Erie and Niagara Falls takes its water from the Niagara River which flows from that lake. Even though water seems to have become perfectly clear and has no mud, taste, odor, or chemical impurities, disease germs may still live and do vast harm. Thanks to modern sanitation, however, typhoid fever is now almost unknown in progressive communities such as Buffalo, and the danger to Niagara Falls is past. In Europe the prevalence of typhoid germs in the water supply of many of the cities is one reason why wine and beer are used so extensively. In practically all American cities, however, and in most of those of Europe the water supply is now so good that it can be drunk with safety. In China, on the contrary, disease germs are still abundant in the water, and the people almost universally drink tea. They have found by long experience that the best way to get rid of bacteria is to boil the water, a lesson which people ought to remember when obliged to use doubtful supplies of water where typhoid and dysentery are common.

How a Water Supply is Procured and Distributed

(1) *Primitive Methods.* The simplest way of getting a supply of water is to dip it up by hand from a stream, spring, or lake. In Oriental or tropical countries such as Persia, India, and Venezuela, one can any day see scores of women walking gracefully to the stream or the fountain with earthenware jars poised on their heads or shoulders. Elsewhere men with plump goatskin bags on their backs or driving barrel-shaped little donkey carts bring water from the muddy river and fill the big earthenware pots that stand in a shady corner of every courtyard.

(2) *Ordinary Wells.* Among rural civilized people and among many who are only partly civilized, wells are the most common source of water. This is because the soil and the solid rock are everywhere saturated with water below a certain depth. The varying level at which permanent water is found is called the *water table*. The water table is only a few inches below the surface in swamps, but generally several hundred feet in deserts. To be a success, a well must penetrate below the lowest level to which this table falls in dry seasons. The chief difficulty with wells is to raise the water to the surface. In backward places this is still done by hand with long ropes. In parts of tropical Mexico long lines of women come to the wells in the cool of the morning long before sunrise and wait their turn in order to pull up water from a depth of a hundred feet or more. Often, however, this work is done by horses, oxen, or camels. In Mexico the well rope is sometimes fastened to the horns of an ox, or the saddle of a horse, where it causes a great and unnecessary strain which soon kills the animals. These primitive methods, however, are fast being replaced by machinery. The simplest machine for drawing water is the hand pump, but pumps run by animal power, wind, or gasoline are also largely used. The use of such pumps usually leads to the building of tanks or reservoirs, and thus makes it easy to have running water in the house at all times. This is a great advantage, for the easier it is to get water the more likely people are to use it, not only for drinking and cooking, but also for bathing, washing, and fire protection. Moreover, such a water system is a great help in insuring purity.

(3) *Artesian and Driven Wells.* The use of machinery has made it possible to drill wells of great depth. Artesian wells are those in which the well penetrates to porous layers of rock lying between impervious clayey layers. The layers must be tilted sufficiently so that considerable areas of the porous layer are exposed at the surface at a level above that of the bottom of the well. These areas receive rain which seeps slowly along in the porous layer and fills it completely not only at the surface but also in its deeper portions far away. When a well penetrates into this deeper portion, the pressure of the water all through the porous layer

causes the water to rise in the well. If the collecting area where the porous layer is exposed on the surface is high enough, the water flows out of the well, and even gushes upward. At Louisville, Ky., the water, if unhindered, spouts up 170 feet. One such well at Lillers in France has been flowing steadily for nearly 800 years. Artesian water from great depths is always warm. A well 2,050 feet deep at Charleston, S. C., for example, has a temperature of 87° F.

Artesian wells are especially important in dry regions such as the Sahara Desert, where they support many small oases. The French have there tapped deep sources of water derived from rain that falls many hundreds of miles away. Kharga and other oases in the Libyan portion of the Sahara, west of the lower Nile, are supported by springs which are natural artesian wells. There the wind appears to have scoured deep depressions in the solid rock, and water flows out where these reach an artesian layer.

Driven wells, which penetrate deep into the ground but do not strike water that rises, are also highly important in dry regions, since they give a water supply which does not dry up. They are expensive to operate, however, since it costs a good deal to pump water from great depths by means of gasoline or electricity. In the southwestern United States such wells are common, but they are much more feasible on cattle ranches, where only a small supply of water is needed, than on irrigated farms where a large supply is required. Moreover, the water from such wells is likely to contain a large percentage of dissolved minerals, which do harm to plants, animals, and man.

(4) *City Water Systems.* The most complicated methods of obtaining and distributing water are employed in great cities. No matter what may be the source of the water, a city must have an extensive system of large water pipes or mains, and of minor pipes running to every street and house. Filtration plants are also needed in many places, and a well-developed system of sewers is always planned in connection with the water system in every up-to-date city. Each city ought also to have a reservoir sufficiently large and located high enough so that in case of sudden demands such as fires or when the mains are broken, there will be enough water for the emergency.

The sources of city water are various. Some cities like Pittsburgh pump water out of rivers and have to spend much money in purifying the water and in raising it high enough to supply the hilly parts of town. Others, such as Chicago, get water from lakes close at hand, and have the same problem of purification and pumping, although the cost of pumping is slight because the city lies so close to lake level. In other cases, as may be seen at the Croton Dam near Croton, New York, the city spends an enormous sum in building great reservoirs far away among the hills.

The Ashokan Reservoir lies among the Catskill Mountains 85 miles from New York, and its water is brought to the city by a great aqueduct which goes under the Hudson River in a very deep tunnel. Although the first cost of such a reservoir and aqueduct is enormous, the later cost is slight. Little expense is needed for maintenance, purification is unnecessary, since the reservoir is protected from contamination, and the water flows by gravity without being pumped. Some of New York's skyscrapers, however, are so high that for a long time they had to maintain their own pumping plants in order to raise the water to the upper stories. Now New York is reaching out still further to obtain water from branches of the Delaware River.

Boston in the same way has constructed the largest lake in Massachusetts in order to use the water of the Quabin branch of the Connecticut River. The water goes under the hills north of Worcester in one of the world's great tunnels, 26 miles long. San Francisco has also driven a huge tunnel under neighboring hills (the Coast Range) in order to bring water from high mountain reservoirs along the Hetch Hetchy River. Los Angeles, being located in a region where there is a long dry season, has to bring its water much farther than New York. It taps the Owens River on the east side of the Sierras at the foot of Mt. Whitney, and brings the water under the Sierra Nevada Mountains in a tunnel. This aqueduct, about 250 miles long, is the largest in the whole world, but Los Angeles wants still more water, and there has been talk of bringing it from a more distant source, the Colorado River.

Cities also get water from artesian and driven wells. Although London gets its supply chiefly from the rivers Thames and Lea, it likewise has a huge system of artesian wells driven into the underlying chalk. So numerous are these wells, and so great the demand of London for water, that the water table has been permanently lowered over a large area. Before Brooklyn shared New York's water supply it had a similar experience on a smaller scale.

One of the most unusual methods of getting a water supply is that of Baku and Aden. Both cities are located in regions so dry that fresh water is very scarce. Hence the best method has been to piece out the meager supply with distilled sea water. This is inexpensive at Baku not only because of the abundance of oil, but because water from the distant foothills of the Caucasus Mountains has now been secured. At Aden, however, where coal must be brought from a distance, the water supply is unusually costly. Still more unusual is the method long employed at some of the nitrate ports on the desert coast of northern Chile. There water was brought by steamer from a distance. If the steamer was late the price of water soared enormously.

Water as a Source of Power

Water furnishes the cheapest kind of power, provided it comes from streams that flow regularly at all seasons and descend rapidly to provide a good "head." The first cost of water power plants may be great, but afterward the expenses are slight. Three conditions are favorable: (1) rugged relief, (2) lakes or other reservoirs, and (3) an abundant rainfall well distributed throughout the year.

(1) *How Rugged Relief Favors the Use of Waterpower.* In a rugged country the streams descend rapidly, thus furnishing a proper head of water. How important this is may be illustrated by comparing the Mississippi River in its upper and lower portions. The available power from the main stream of the river during its course of nearly a thousand miles in the great central plain, where it descends only 5 inches per mile, is only 147,000 horsepower. A smaller amount of water flowing a similar distance in the upper tributaries in regions of rugged relief where it descends rapidly, is capable of furnishing 6,430,000 horsepower, or about 43 times as much as in the plain.

(2) *How Lakes Favor the Use of Waterpower.* Lakes are also a great help in the development of waterpower. They serve as reservoirs so that the volume of the rivers which flow from them varies relatively little from season to season. For example, the Niagara River, coming from the huge reservoirs of the Great Lakes, carries only one-third more water at its highest than at its lowest level. The Potomac, with no lakes whatever, sometimes at flood seasons carries 250 times as much water as in dry seasons. In July, 1911, a drought caused the lakeless Catawba River in the Carolinas to become so low that 152 cotton mills shut down for lack of power, and 70,000 operatives were thrown out of work. Such variations do so much harm that power companies have spent millions of dollars in creating artificial lakes by means of dams on rivers such as the Connecticut and its tributaries.

The presence of abundant vegetation has somewhat the same effect as lakes in steadying the volume of rivers. Where the slopes are well covered with vegetation, the rain does not run off all at once, but is caught in the rootlets and soil, so that it seeps out slowly in springs. This is one of the chief arguments for forest conservation.

(3) *How Abundant Rainfall Favors the Use of Waterpower.* The value of abundant and regular rainfall in promoting the use of waterpower may be judged from a comparison of Wisconsin and Nevada. Although Wisconsin is only half as large as Nevada and less rugged, its heavier rainfall makes its potential waterpower several hundred times as great. In Washington, Oregon, and Idaho abundant rains on the west slopes of high mountains make that region capable of furnishing two

fifths of the waterpower of the United States. If all the waterpower there could be developed, it might furnish nearly 15,000,000 horsepower, that is, more than is obtained from the 150,000,000 tons of coal burned each year by the railroads. Already a good share of this power is ready for use, especially in the huge dams of the Grand Coulee and Bonneville along the Columbia River in Washington. There the world's most massive and expensive dam, the Grand Coulee, will furnish 2,700,000 horsepower when all its capacity is utilized, and it will also irrigate thousands of acres. This water, however, does not come from the most rainy mountains, that is, the Coast Range, or even from the Cascades, but from farther east. Where the rain is heaviest, the streams are so short and steep that it is hard to build reservoirs.

(4) *How Seasonal Variations Hinder the Use of Waterpower.* The chief disadvantage of the northwestern waterpower is that, although the rains fall heavily part of the year, they diminish greatly in summer. In the United States the irregularity of the rains reaches a maximum in the Southwest. The winter rains on many mountains in Utah, Arizona, and southern California would furnish abundant waterpower, but unless large reservoirs are possible it does not pay to build power plants because they would have to be idle during the long dry summer, and the industries dependent on them would be handicapped. Moreover, they might be ruined by the floods which are characteristic of such regions, where the bare slopes of the mountains have little vegetation to hold back the water in winter. Some of these mountains, however, are so high that much of their precipitation takes the form of snow. If this melts slowly it acts like a reservoir, and holds back the water until the warm dry season when it is needed. Sometimes it melts rapidly and forms bad floods. In spite of these difficulties some of the largest waterpower plants, such as the Roosevelt Dam in Arizona and Boulder Dam on the Colorado River between Nevada and Arizona, are found in the Southwest. This is partly because the dry climate makes it pay to build dams for irrigation as well as for power.

Boulder Dam holds back more water than any other in the whole world, 10,000,000 million gallons. Its nearest rivals are the Fort Peck Dam on the Missouri River in Montana (6,350,000 million) and Grand Coulee (3,130,000 million). Where the flow of rivers is fairly steady it is not necessary to hold back so much water. The great Dnieper Dam in southern Russia, which cost almost as much as Grand Coulee, is only 200 feet high, in contrast to the 727 of Boulder Dam, and holds back only 300,000 million gallons of water. The Assuan Dam in Egypt, on the other hand, is of little use for power because seasonal variations are so great that all the water is let out of the reservoir at the time when the needs of irrigation are greatest.

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Keystone View Co.

A—Boulder Dam in Arizona.

Water is being released through some of the 12 "needle valves," or rock hewn tunnels such as those of which the mouths are seen in the foreground. The tunnels are used to let out surplus water in flood seasons.

Why Glaciated Regions Have Abundant Waterpower

(1) *Falls and Rapids.* The parts of the world which possess the most favorable combination of rugged relief, many lakes, and abundant rainfall have all been glaciated. As the great icesheets of the cold, stormy glacial period moved slowly forward from cool, stormy, elevated regions, they changed the topography in such a way as to improve it for waterpower. Rivers were turned out of their courses so that they formed numerous falls and rapids, and great hollows were formed which are now filled by lakes. Niagara Falls, the most easily used and favorably located of the world's main sources of waterpower, came into existence because ice closed the ancient outlet of Lake Erie. The lake overflowed along a new course, and therefore tumbles over a cliff so that today Niagara Falls furnishes light and power to multitudes of people. The falls might furnish 3,000,000 horsepower, or nearly a sixth of all that is used in the United States, if the governments of the United States and Canada had not imposed restrictions in order to preserve the natural beauty of the tremendous waterfall.

In New England, Wisconsin, and similar regions the ancient glaciers did not cause such striking falls as at Niagara, but gave rise to many smaller ones, and to frequent rapids which can easily be dammed. This has stimulated the growth of such industrial cities as Manchester, Nashua, Lowell, and Lawrence on the Merrimac River; Holyoke, Springfield, and Hartford on the Connecticut; and a string of small cities on the lower Fox River in Wisconsin.

In mountainous regions the ancient glaciers deepened the valleys and steepened their walls so that tributary streams often enter the main valley in a series of cascades which can readily be utilized for power. In Switzerland and Norway, where glaciers persisted in many valleys for thousands of years after the continental glacier had retreated, such falls are numerous, and are one reason for the preëminence of those countries in the use of waterpower.

(2) *Glacial Lakes.* Over 90 per cent of all the lakes in the world are due to glaciation. In some of them, such as the Great Lakes, the Finger Lakes of Central New York, and the famous lakes at the foot of the Alps in northern Italy, the glaciers dug out enormous hollows which were filled by water when the ice melted. In others, such as hundreds of lakes in New England, Wisconsin, Canada, and Russia, the ice laid down great masses of rock and soil called moraines, and these caused lakes by acting as dams. Wherever such lake regions have sufficient relief they afford the conditions needed for the development of abundant waterpower. Glacial lakes, falls, and rapids, for example, helped early New England to develop manufacturing industries. They are still a valuable asset although

coal is now a more important source of power. In Sweden, Norway, and Finland, glacial streams play a still larger part in the industries.

(3) *The Value of Waterpower in Switzerland.* High mountains and glaciation together with competent people cause Switzerland to be one of the most advanced countries in the use of waterpower. The power used by practically all the street railways there and by the bulk of the industrial enterprises comes from waterfalls. The railroads, too, depend mainly upon hydroelectric power derived from electricity generated by the streams that pour down from the mountains. The loom of the lacemaker and the machine of the watchmaker in the home are also driven by hydroelectric energy. Much electrical energy goes into the barn and house of the peasant. Thus grain is threshed, butter is churned, water is pumped, food for cattle is prepared, and the farmer is relieved of some of his most arduous labor. Much of this is due to a wise policy of government regulation and assistance, whereby the state retains the ownership of the waterpower sites, but private enterprises are encouraged.

Increasing Use of Waterpower

In the past, many of the best waterpower sites have been unavailable because located in mountainous regions where the population is scanty, the rough ground affords little opportunity for factories and houses, and transportation is expensive. At last, however, hydroelectric methods of transmitting power have so developed that nearly half of the possible waterpower of the United States has been developed. Not only is a 400-mile transmission line in operation in southern California, but still longer lines are planned or in operation. Engineers are considering the construction of a 700-mile line in Africa from the Victoria Falls of the Zambezi to the mines at Johannesburg. Of still greater importance is the proposed superpower zone, a plan for linking together all the sources of power in the northeastern United States.

No other waterpower site can hope to rival Niagara. The size of the river, the sudden fall from a great height, the regularity of the rainfall, and the steadiness of the river because of the great reservoirs back of it are all advantages of the highest order. Moreover, the falls are located in a comparatively level region where transportation is easy and cheap, and where there is plenty of room to establish factories and build houses. And finally, the falls are in a district where the population is dense, energetic, and progressive, and which even without waterpower would be one of the world's great manufacturing regions.

The nearest rivals of Niagara are both called Victoria Falls. One, the Zambezi, is more than twice as high as Niagara and carries an enormous volume of water. The other, on the River Iguassu on the boundary

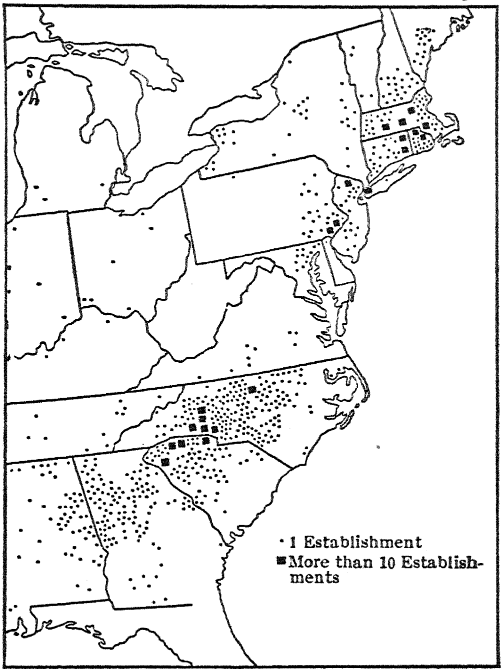
between Brazil and Argentina, and only 16 miles from Paraguay, is 215 feet high and has a series of twenty falls separated by islands just as Goat Island separates the American and Canadian Falls at Niagara. Neither of the two Victoria Falls has yet been used for waterpower because both are located in unfavorable climates far from manufacturing centers.

One of the most-discussed power projects is run by the T.V.A. or Tennessee Valley Authority. At Muscle Shoals the Tennessee River swings south into Alabama, the river drops 132 feet over a series of rapids in a distance of 37 miles. In floods the river has a volume of 500,000 cubic feet per second and does much damage. In dry summers it drops to only 5,000 and the river is useless. In order to make the river useful the United States government began building a great power plant here during the first World War. For fifteen years after the war a great political battle raged around this dam between advocates and opponents of the policy of having the government run the power plant. Finally in 1933 a policy of government operation was established. Seven large dams have been built for the threefold purpose of making the Tennessee River navigable, preventing floods, and providing electric power. About a million horsepower are available, and many farmers and village people are using electricity as never before.

Local Geography of Inland Waters

The local geography of inland waters can be observed everywhere, for even in the driest deserts rain sometimes falls. One of the first things to note is the location of rivers, brooks, springs, swamps, ponds, and lakes, and the effect which each of them has upon human occupance of the land. Railroads and factories may be located near rivers both because the land is level and because the river affords a means of transportation and an easy way of getting rid of waste water. The land near a brook may remain unoccupied long after the surrounding land has been built up. This may be because it is swampy, or low, or badly drained, or merely because it would be expensive to restrain the brook in time of flood. In other places the beauty of a brook, river, pond, or lake is the reason for building pleasant houses, either for summer use, or as permanent homes. A most interesting study can be made of the kinds of river banks or lake shores that attract different types of people for residence, for recreation, or for business of various kinds. Parks and parkways tend to be laid out along waterways, and owe much of their beauty to them. Some streets of many cities are subject to flooding during rains, and some sections of a city or village are in danger of having their cellars flooded. Such facts are both interesting and important as parts of a study of local geography. So, too, is the effect of bodies of water on the location and windings of

roads. The erection of a bridge is often the most expensive part of making a road. Many modern motor roads still have bottlenecks where a broad road contracts to the narrow width of an old bridge which it has not yet been feasible to replace. Still more important is a study of the local water



A—Cotton Mills in the United States.

supply. Where does the water come from? Is the watershed so well protected that the water does not have to be purified? Where and at what height are the reservoirs? A map of the water supply is worth making no matter whether one lives in a city such as Cleveland or on a farm. The same thing is true of the disposal of sewage, and its relation to the pollution of wells out in the country, and of rivers and harbors near cities.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Discuss the relation of the following places to inland waters: Pittsburgh, Manchester, N. H.; Fall River, Richmond, Raleigh, Boulder, Hetch Hetchy, Fort Peck; Mainz; Belgrade; Assouan; Minneapolis; Ashokan. What bodies of water have helped to make these places important? To what uses is the water put in each place?

2. Give reasons why New England rivers are more or less useful for either power or navigation than the rivers of the Carolinas and Georgia.

3. Try to find out from a relief map and a rainfall map what are the prospects of getting enough waterpower to run factories in New Zealand. Find out other conditions which may cause industry to develop.

4. "North Italy has undergone an industrial revolution during the last century." To what extent is this development due to inland waters?

5. What connection can you see between a map of cotton mills (A277) and inland waters? How important is it?

PART VI

MAN'S RELATION TO SOIL AND MINERALS

CHAPTER XIII

SOIL AND THE FARMER

Poor Soil and Poverty versus Rich Soil and Prosperity

In the middle of Pennsylvania, close to Pennsylvania State College, a little tract 13 miles long and 2 or 3 miles wide illustrates the effect of the soil. It lies in the Nittany Valley at the southeastern base of the steep slope, or escarpment, up which one must climb to reach the Allegheny Plateau. The Barrens, as it is called, was largely occupied by farms in the early days when the country was first settled. Little by little, however, the farmers became poor and turned to other occupations. Gradually the farms and finally even the villages were abandoned. Today the whole tract is almost uninhabited and is covered with a poor kind of timber. Outside the Barrens, the farms have a prosperous comfortable look, and there are many dairy cattle. The farmland is cleared and improved more fully than in all except five or six of the more urban counties of Pennsylvania. The yield of crops per acre is generally greater than that in Pennsylvania as a whole. When one drives from this pleasant, well-populated region into the wooded, uninhabited Barrens, it is almost like going into another country. The difference is due almost entirely to the soil. The Barrens have an infertile soil derived from a poor sandstone. A few years of cultivation exhaust it. Therefore the early settlements could not survive. The rest of the Nittany Valley has a rich soil derived from limestone and capable of producing good crops decade after decade.

A similar contrast is seen between the best and worst soils even in a state such as Iowa, where most of the soil is excellent. In eleven counties with unusually good soil a farm of standard size, 160 acres, yields an income about two thirds greater than in eleven counties where the relief of the land is similar but the soil is poor. In the counties with the better soil the percentage of farmers who own trucks and tractors and have bathrooms, radios, and other conveniences in their houses is much greater than in the others. In the counties of good soil the local stores are larger,

the average person buys more, a larger percentage of the young people go to high school and college, and in general the standard of living in the villages as well as on the farms is higher. All over the world differences of this same sort accompany differences in the soil.

The Relation Between Soil and Plants

Living beings depend upon the soil for existence, the plants directly, and animals and man indirectly. Therefore the poets are right when they speak of the earth as the mother of all things. To suppose, however, that the soil supplies the main food of plants is a mistake. It supplies only 3 to 7 per cent of the dry weight of plants. The rest consists of carbon, oxygen, and hydrogen, derived from water and from the carbon dioxide of the air. The soil, however, is the agent through which water must usually pass in order to reach the plants. It also serves to support their roots and hold them upright.

Thus the functions of the soil may be summed up as follows: (1) to act as a physical support of vegetation, (2) to serve as a medium for storing water and bringing it into contact with the roots, and (3) to supply a small but essential percentage of the materials which are converted into plant food by means of light. This small percentage is absolutely essential. In a certain way it bears to the main elements a relation analogous to that of salts, acids, and vitamins to the carbohydrates, fats, and proteins which form most of the food of man. The various chemical elements derived from soil, air, and water are not exactly plant foods when first absorbed by the plants. Before they can nourish the plant they must pass through the chlorophyll cells and be changed into starch, sugar, proteins, fats, and other substances like those which nourish animals. They cannot do this unless the chemicals of the soil as well as the air are present.

Because the soil is so necessary for the formation of chlorophyll, and thus for all growth, the soil becomes a great human problem, involving an expense of hundreds of millions of dollars each year. Although water and carbon dioxide supply most of the bulk of plants they create no such problem because there is no danger of exhausting the supply. The necessary chemicals of the soil, on the other hand, can be rapidly exhausted. Each year we put back only part of the fertilizing elements that we take away, so that year by year the soil becomes less fertile and the earth poorer. Some day we shall realize that among the things that man wastes or destroys none is more important than the common soil beneath our feet.

How Soil is Formed

(1) *Mechanical Agents.* All soil is derived from rocks by means of mechanical, chemical, and organic processes. The mechanical processes consist of breaking rock into small fragments in the following ways:

(1) When rocks are heated by the sun and cooled by wind and rain, they alternately expand and contract. This causes them to crack like a piece of glass in hot water, although not so violently. The Sphinx in Egypt has been chipped in this way. (2) The rocks are also broken by movements of the earth's crust. The largest movements are earthquakes. Still other cracks are formed because rocks contract while cooling and hence split a little and then settle downward. Even where the rocks appear solid their upper parts are broken by innumerable cracks. (3) Into cracks formed in any of these ways rainwater percolates sooner or later. If it freezes, it expands and thus pushes open the cracks a tiny bit and forms new ones. When it melts, the water settles into the enlarged openings. Then, if it freezes again, they are enlarged still more. (4) Where small particles of rock lie on the surface, running water, waves, and winds move them and grind them still finer. At the same time the removal of the soil by these agencies exposes new rock. On Cape Cod, for example, and in deserts, the wind sometimes carries loose sand with such violence that windows become etched and people cannot see through them.

(2) *Chemical Agents.* The cracks formed by mechanical agents make it easy for chemical agencies to convert the rock into soil. The water that percolates into the ground is sure to contain impurities. From the air it gathers some of the carbon dioxide given off by volcanoes, by animals when they breathe, and by decaying vegetation. On the surface of the ground it seeps among rotting leaves, roots, and other organic matter, and dissolves humic acid, ammonia, and other chemicals. Thus the water becomes a weak chemical solution, usually acid, and is able to dissolve some minerals and weaken others.

The air itself, especially when moist, produces similar results. The water, oxygen, carbon dioxide, ammonia, and other substances which the air contains in minute quantities cause decay. The process is like the rusting or oxidizing of iron, which sometimes goes on so rapidly that a bright blade may become red when left out of doors overnight. Oxidation is the commonest method by which rocks are converted into soil. The red, yellow, or brown coating on the outside of rocks is the result of oxidation.

(3) *Organic Agents.* Anything which helps to expose bits of rock to the attack of air or water helps to make soil. (1) A lichen helps when it attaches itself to the side of a bare, solid rock. The higher plants help when they send rootlets into cracks. As the roots grow the cracks are forced open. (2) Animals such as woodchucks and prairie dogs expose bits of rocks to the air when they dig their burrows. The patient ants in the same way bring up innumerable tiny bits of rock and place them within reach of sun and rain. Angleworms get their food by eating the

fine soil. In the process of digestion they take out the decaying organic matter, while the soil passes through them and is subjected to chemical action.

If all the soil of a given region were swept into the ocean the mechanical, chemical, and organic processes here described would in time break up the exposed rocks and form a new cover of soil, but it would take hundreds of thousands of years.

Texture of Soils

(1) *Gravelly Soils.* The value of soils varies greatly according to their texture. Gravelly soils, such as are formed by swiftly running water are too coarse for most kinds of plants. They allow air and water to penetrate freely to the roots, but do not retain the water, and the crops are likely to dry up. Moreover, although the roots can find their way easily among the particles, the soil does not furnish soluble chemicals in sufficient quantities. Gravelly soil is also hard to plow and cultivate because of the stones. When a flood in the Miami River spread four or five inches of gravel over some of the farms in Ohio the farmers were completely discouraged at first. Then they went to work with tip carts and laboriously cleared off the gravel acre by acre.

(2) *Sandy Soils.* Sand, which usually consists largely of quartz grains, has similar disadvantages. It is, indeed, easy to plow and cultivate, but it furnishes little nourishing material for plants, and the water runs through it quickly. In the sandy "pine barrens" of Carolina, Georgia, and Florida the water escapes so fast that only hardy trees and grasses can grow, and farms are scarce. In Florida the orange grower must each year give his groves tons and tons of fertilizer, because the sand in which the orange trees grow contains such small supplies of the essential chemicals.

(3) *Clayey Soils.* Clay has the opposite faults from sand and gravel. It is so sticky and compact that plowing is difficult. Only strong types of plants, such as grasses, can send their roots into it. The well-digger dreads "hardpan," as he calls a layer of clay, almost as much as solid rock. In Chinese Turkestan certain streams used for irrigation bring down large quantities of clay and spread it on the fields to a depth of two or three inches in a single season. When the clay dries it forms a solid cake so hard that it must be left two or three years before it can be cultivated.

(4) *Loamy Soils.* The best soils consist of *loam,* a mixture of sand, silt (very fine sand), and clay. Some sand is desirable to make a soil friable so that it is easily broken up by the plow or hoe, and easily penetrated by roots. Silt is desirable for the same reason, and because its particles are so small that they can readily be weathered into clay, thus providing fresh

chemicals in soluble form. Both sand and silt, be it noted, are genuine rocks in spite of their size, and are of no immediate use as plant food. The food all comes from clay, which is rock that has been oxidized and otherwise altered so that parts of it are soluble. Only these soluble parts ever get into plants. Thus some clay is essential.

Transported Soils

Why They are Generally More Fertile Than Residual Soils. The character of a soil depends partly on the degree to which soils from various sources have been mixed, so that all the necessary chemical elements are present. Soils that have not been moved from their place of origin are called *residual,* because they *reside,* as it were, where they were first formed. Residual soils derived from quartz rocks, such as quartzite or sandstone, are likely to be so sandy and poor that farmers can scarcely make a living. The residual soil derived from dark heavy lavas, or from limestone, on the other hand, is generally rich in essential chemicals, but often has the disadvantage of being clayey and sticky. Sometimes in wet weather the horses can scarcely pull the plows and the plowman's boots are almost dragged from his feet, or a tractor bogs down. If fine sand is mixed with such soils they form loams which are soft, pliable, easily worked, and highly fertile.

Fortunately a large portion of the earth's soil does not remain where it was formed. It is carried by running water, glaciers, or wind and mingled with other soils. Thus sand and clay are brought together and form loams. A soil that is poor in one essential ingredient is mixed with a soil that is rich in that respect. Hence transported soils are on the whole much better than residual soils. They are found as a rule in plains and lowlands while residual soils prevail in highlands. That is one reason why plains are more prosperous than mountains.

Alluvial Soils. The most valuable transported soils are found in the alluvial deposits laid down by rivers and other streams. At their best such soils are derived from so many sources that all the necessary chemical elements are well represented. They also consist of a well-proportioned mixture of sand, silt, and clay, but are free from stones. In addition to this they have two qualities which we shall discuss in a moment, namely, sufficient humus and sufficient maturity but not old age. Therefore it is not surprising that the world's densest population is found on great alluvial plains, such as those of China, India, Egypt, the Rhine Valley, and our own Mississippi. Regions that were recently parts of the floor of the sea or of lakes share these good qualities, as in Denmark, the Netherlands, and the old lake bed of the Red River region in Minnesota and North Dakota.

How Transportation by Glaciers Improves the Soil

Glaciers, as well as rivers, may deposit good soil. One of the most characteristic actions of icesheets is that they scour off the hilltops and deposit the materials thus obtained at other points which may be far away. This "drift" material, as it is called, consists of fine soil mingled with boulders. It often is deposited in low places and tends to fill up the hollows. The transported soil thus formed is improved by the mixture of materials from one region with those from another. This is especially true where drift from a limestone area is brought into a region of sandstone. The following table, prepared by Professor R. H. Whitbeck, shows the difference between the average yield per acre of crops in the small "driftless" part of Wisconsin and in adjacent counties where the icesheet did its work.

Average Number of Bushels per Acre

	Corn	Rye	Potatoes
Driftless counties....................	21.0	9.6	76.0
Glaciated counties....................	25.3	11.3	107.0

In every case the glaciated soil yields a larger return. The reason is that the driftless areas have a poor sandy residual soil, whereas the glaciers fertilized the adjacent counties by large quantities of drift from limestone areas. It is as if the farmers had brought lime for fertilizer. The presence of such fertilizers is worth millions of dollars to many glaciated regions. Professor Whitbeck estimates that Wisconsin benefits thereby to the extent of at least $50,000,000 per year. Because of this extra income Wisconsin has better roads, better schools, and a better university than would be possible otherwise.

In regions such as eastern Canada and Finland, however, the glaciers in many sections scraped away the good soil, leaving only bare rock. Where the material thus scraped up has been deposited, it is often so full of stones as to be of little use for farming.

Humus and Soil Nitrates

No matter how excellent the texture of a soil may be, or how diverse the sources from which it comes, a soil is useless unless it contains nitrates. These compounds of nitrogen are absolutely essential to the formation of protoplasm, which is the basic material of all life. They are formed by combining atmospheric nitrogen with oxygen, hydrogen, and some element such as sodium or potassium. No animal can make this combination for itself, and most plants cannot do it. The chief makers of nitrates

are certain forms of bacteria which live in the soil. Until they have done their work no higher plants can live. This is one reason why a newly cut bank often remains without vegetation for years. After the top layer of the soil has obtained a little nitrate from nitrogen-fixing bacteria, the process of supplying nitrate is hastened by other bacteria which live on the roots of plants. The most active of these form nodules on the roots of clover, beans, and other members of the legume family. For this reason legumes are often raised as fertilizer and plowed under to help other crops. Inasmuch as all plants contain nitrates, the addition of dead plant material helps to build up a soil. The material thus added is called humus. Alluvial plains of rivers owe part of their fertility to the fact that usually the flooding of the streams causes grasses, reeds, and other vegetation to be buried in mud, thus adding humus to the well-mixed soil brought down from higher levels.

Movement of Materials within the Soil

Soil Profiles. While a soil is decaying on top of the original rock, or is being built up by water, ice, or wind, it by no means remains the same for century after century. On the contrary, it grows older in stages somewhat like those of youth, maturity, and old age in living creatures. Part of the process of aging consists of the movement of materials up and down within the soil itself. In this way a typical soil in regions of moderate rainfall acquires three parts. One, the so-called A horizon, is the upper layer which contains humus and is the most essential part so far as the growth of plants is concerned. It may be of any thickness from an inch to a foot or more. Below it comes the B horizon, which does not contain humus and is therefore of a lighter color than the A horizon. As rainwater soaks down through this layer it dissolves some of the chemicals which have been set free by weathering, and carries them downward. It also often carries down some of the finest clay. These materials ordinarily do not go very far. At a depth of a foot or two they begin to be deposited. This gives rise to a third horizon of still a different color, called the subsoil. The materials in this horizon have not been sufficiently oxidized to be good for the immediate use of plants, but if plowed up and exposed to the air, they soon become useful. This is one reason why deep plowing is valuable, especially in poor soils.

Climate and Soil

Soils of Different Ages. In the long run the quality of a soil depends on its age and the climate under which it has developed even more than upon the original rocks from which it came. All very old soils in any given climate are much alike, no matter what their origin. They have

decayed so much that everything which can become soluble, even though very slowly, has been washed away. Thus old soils may become so completely leached that they are mere skeletons. They often take the form of extremely fine, deep, and sticky clay, which becomes very hard and stiff when dry, but sometimes they are almost granular like sugar. Such old soils are exceedingly poor for crops, although even the oldest support some sort of vegetation, especially grass. They sometimes have a depth of 20 or even 50 feet, but the lower parts are not yet old. Very young soils are not much better than old soils. They are shallow, coarse, and full of fragments of unchanged rock. Only a small part has yet been converted into real clay, and thus become fine enough to yield up the chemical elements needed by plants. Then, too, such soils are usually deficient in humus. One can judge how poor they are by looking at the vegetation in almost any gravel pit, or even in places where the turf has been skinned off.

Between the young and the old stages there must evidently be a mature stage. In this the soil is fairly deep; it contains at least a moderate amount of clay, but also some coarser material in the form of sand. This makes it more friable than old soil, but more retentive of water than coarse young soil. It has decayed enough to allow the plant foods to be available, but not so much that they have been almost leached out. Thus maturity is the stage of a soil best fitted to agriculture. Of course any soil can be improved by being plowed up and fertilized, but in a well-drained and well-aerated mature soil this is far easier than in either a coarse young soil or a clayey old soil.

The Effect of Climate on Weathering. Weathering, like practically all chemical processes, is greatly accelerated by heat as well as by moisture. When soil is frozen, chemical changes almost cease. At temperatures near 90°, on the other hand, the weathering processes are greatly accelerated, especially if moisture is abundant. Moreover, at low temperatures plants are scarce, so that the water in the soil is comparatively free from acids and other chemicals. At high temperatures, on the contrary, there is almost invariably much vegetation which decays quickly so that the water is strongly charged with chemicals. Such conditions greatly accelerate weathering, so that in moist regions the soil may grow old a hundred times as fast as in very cold regions where frost prevails a large part of the year. Hence, even if all soils were of the same age in years, we should expect them to change gradually from young types in high, cold latitudes to old types in low latitudes.

A Soil Section from North to South. The geographical distribution of soils agrees with what we should expect from the preceding paragraphs. In general they are young, pale, shallow, coarse, and of poor quality in

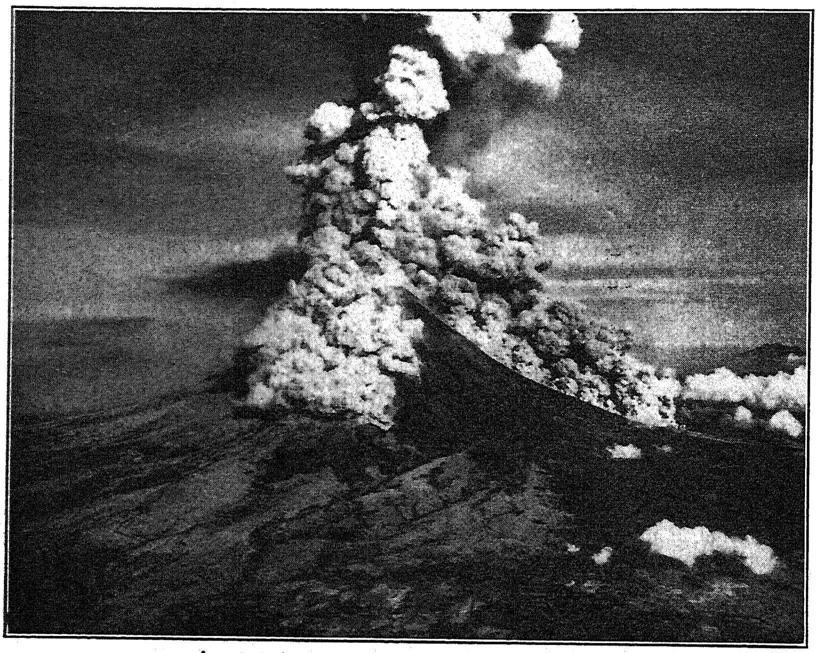
the far north, as appears in Plate I at the end of this book. The worst of such soils are found in the tundra where the only vegetation is lichens with some grass and flowering plants, but no trees. They become better in the podzols, or light-colored soils of the northern forests, but are still quite poor. Farther south, on the east side of North America, let us say, we reach the belt of mixed forests where conifers and broad-leaved deciduous trees are mingled (A363). There the higher temperature and more varied vegetation tend to produce browner soils which are fairly mature and hence reasonably fertile. Of course the soils here, as everywhere, vary greatly according to a great variety of non-climatic conditions, including the nature of the underlying rock, glaciation, volcanic activity, uplift from under the sea, and deposition in floodplains. Nevertheless on an average, the humid brownerths, as these soils are called in Plate I, are mature and fairly fertile, and better than those in either cooler or warmer regions. They provide one of the many advantages which make the middle latitudes the best parts of the world.

Farther toward the equator the soils on an average become older and more leached. They tend to assume yellow and red colors, Plate I. The warm weather causes these rederths and yellowerths to decay so rapidly that in many places they have passed the most favorable condition of maturity and are on the down grade. This means that they are too clayey, and so leached that they have lost much of their plant food. Finally, the soils of equatorial regions are largely lateritic. True laterites are very old soils from which practically all the soluble material has been leached. They are red, very deep, and practically useless for agriculture. These very old soils in low latitudes have the same practical effect as very young soils in high latitudes.

The Importance of Soils in Low Latitudes. The character of the soil is more important in low latitudes than anywhere else. In high latitudes the poor quality of young soils makes little difference because the climate is too cool for agriculture. In middle latitudes, even though there are many poor soils the tendency is toward maturity and fertility. In lower latitudes, however, the climatic conditions which foster a luxuriant growth of vegetation also foster poor, leached soils. For this reason any conditions which lead to younger soils are advantages. The best of such soils are derived from recent volcanic eruptions. Java is the most famous example of this. That island, only about the size of Iowa, is able to support more than 40 million people because it is largely covered with recent volcanic material, which under the influence of the tropical climate soon forms mature and very rich soil. Neighboring islands, such as Borneo and New Guinea, cannot support nearly so many people because their soil is older. Many of the West Indies also have large areas of volcanic

soil, as do the Hawaiian Islands. This makes them among the best of tropical countries.

Residual soils on slopes of the correct steepness furnish another tropical type which is mature and fertile in spite of the warm climate. On such slopes the topsoil is gradually washed away, and thus the underlying soil is exposed before it is too old. If the slope is too steep, as in mountains, the soil may be washed away before it is mature, but in any given region some slopes are just steep enough so that their soil has the right degree



A—A Volcano Belching Forth Sulfurous Steam.

Discuss the advantages and disadvantages which come to a country because of volcanoes such as this.

of maturity. This is very important, as an American in Brazil found to his cost. He saw large level areas of the old plateau untilled and covered only with grass where poor cattle were grazing. He also saw that the Brazilians were cultivating the sloping sides of the valleys and even making terraces there. "How stupid," he said. "I will show these foolish Brazilians how an American does things on a big scale with good tools." So he hired some flat land, brought American machinery, and plowed up a big piece. But his corn crop was very poor. He tried again with no better success. Then he discovered that the old, deep, lateritic soil on the level uplands can be made fertile only with great expenditure for fertilizer

and cultivation, whereas the mature soil on the slopes will produce good crops. For this reason coffee and various other tropical plantation products are almost invariably grown on slopes. The tropical people do not know why they do this, but they know that coffee planted there grows far better than on the level uplands or in the valley bottoms.

The alluvial deposits of valley bottoms and the coastal plains along coasts that have been recently uplifted also provide good mature soils in tropical regions. The valley deposits are usually derived from mountains where the slopes are so steep that the soil is washed away while still young. If it has a chance to weather properly, with periods of moisture alternating with those of dryness which allow the entrance of air into the pores of the soil, it soon forms rich soil. A great many tropical valley bottoms, however, suffer because they are waterlogged much of the time, or else flooded by heavy seasonal rains. This is true of vast areas along the Amazon and on the coasts of New Guinea and Borneo. There the land is so flat that it is doubtful whether it can ever be drained in such a way as to allow the soil to become properly aerated. This has much to do with the backwardness of such regions. Sediments at the bottom of the sea also have no chance to be oxidized and turn into mature soil. When they are uplifted, however, they soon become mature under the influence of the tropical climate. Hence within the tropics the coastal soils are often quite fertile. This condition, together with ease of transportation by water, helps to explain why most of the world's sugar is raised on plantations near the seacoast. From all this it appears that, although enormous areas within the tropics are greatly hampered by poor soil, certain areas such as volcanic regions, slopes that are neither too steep nor too flat, and well-drained young plains in valley bottoms or along the seacoast have good soil. Hence the great majority of tropical people are found in such places, while vast areas, like the Amazon and Congo valleys and New Guinea, are quite sparsely populated and their inhabitants are very backward.

Wet Soils versus Dry Soils. In Plate I the soils are divided into two great types, pedalfers and pedocals. Pedalfers are soils that have been formed under conditions so humid that the calcium (lime) in the upper parts has been washed out, although the aluminum and iron are left. The syllable "al" in the word pedalfer indicates aluminum; "fer" indicates the Latin word for iron which occurs in such words as *fer*ric iron ore and *fer*romanganese. In Plate I such soils are indicated by lined rulings, and are seen extending all the way from arctic regions to the equator on the east sides of the continents, but not on the west sides. This is because the east sides are everywhere well watered, and hence the soils are more or less leached. The pedocals get the last syllable of their name from the

word *cal*cium. The syllable "ped" comes from the Greek word meaning ground, which we find in such words as *ped*iment. They are soils that have been formed in climates so dry that the calcium is not washed out of the upper soil. This is a good thing up to a certain point, but it may be accompanied by two disadvantages. One is that in dry regions vegetation is not abundant and hence the chances to accumulate humus are small. The other is that, where the soil is too dry, the water does not flow away underground, but comes up again to the surface and there evaporates into the air. The result is that the lime and other materials which it dissolves are not carried away, but are left near the surface in a cake known as hardpan which makes it difficult to cultivate the soil.

Grassland Soils and a Cross-section from East to West. In middle latitudes a cross-section from east to west shows that the soil improves as one goes from the seacoast inland. Then a deterioration ensues in the arid regions of the interior and on the west coast. This is especially clear in the United States. The best soils of the East are found in the mature humid brownerths of places such as Pennsylvania (Plate I). Farther west, however, in the prairies of Illinois and Iowa, these change into better and darker soils known as prairyerths. These are almost black and the black part is often a foot thick. In the early days the settlers first took up farms close to the rivers. There they had the advantage of being among trees and near running water, but the soil is of the brown forest type like that farther east. The settlers soon discovered that the darker soil back from the rivers on the open grasslands was much more desirable. It was harder to get water and wood there, but the soil gave much larger yields. In fact the situation was just the opposite of what we have seen in Brazil, for the level interfluves or spaces between the streams are the best, not the worst. The difference lies in the fact that in true prairie regions in middle latitudes the winters are cool enough, the glacial soils young enough, and the amount of leaching so slight that the richness of the soil still remains, instead of being washed away, as in Brazil. One of the main differences between the soils of forests and grasslands lies in the fact that grass has a far larger proportion of roots than trees have, and the grass roots are short-lived. Dig into a piece of turf, and see how closely the upper soil is packed with roots. Then dig a bit in the woods and see how much more scarce the roots are. Bear in mind, too, that many grasses are annuals, and even the perennials are by no means so long-lived as trees. The result is that innumerable grass roots die each year in the grassland, but not in the forest. The coolness of the climate and the moderate rainfall allow the grass roots to remain in the soil and form humus. Moreover, since the grasslands are drier than the forests, more lime remains in the soil. Thus we get our rich prairie soils.

In the western parts of the American prairies and in the southeastern parts of the corresponding grasslands in Russia the climate becomes quite dry. Abundant grasses still grow, but there is not rain enough to wash the lime out of the soil. Nevertheless, there is rain enough so that hardpan does not accumulate. Hence in a belt from Saskatchewan through Nebraska to Texas, and again in the Black Earth Region of Russia and Siberia (Plate I), we find the best soils of the whole earth. Unfortunately the largest crops per acre are not also found there because the dryness, especially the dry winter, keeps the yield per acre low except in a few especially favored sections.

West of the blackerths the soil begins to assume a redder shade and we get a belt of chestnut-colored soils. These arid brownerths are very fertile, although not quite equal to the blackerths. Their great defect is that the climate is so dry that the crops often suffer, or even fail completely. They occupy the climatic area where dry farming is especially important. Still farther west, where the aridity is still greater, we find the grayerths, the typical soils of dry regions. Where there is no hardpan they contain a great amount of all sorts of plant food aside from humus, for they suffer very little from leaching. The lack of humus is a serious defect, but if a crop like alfalfa is planted, which is able to take nitrogen from the air, the presence of the other plant foods insures fine crops, provided of course there is irrigation.

In this discussion of the soil we have been obliged to speak in very general terms. The very nature of soil as decayed rock causes an infinite degree of local variety, so that some good soils and some bad ones, and soils of almost every quality and color, may be found close together. Nevertheless, as a general rule the soils improve as one goes from high latitudes to middle latitudes, and then deteriorate again toward the equator. They also improve as one goes inland in middle latitudes from the humid east coast through the forests to the grasslands. Then they deteriorate again as the climate becomes drier and drier. Where the soil reaches the highest quality along both of our cross-sections, that is from north to south and east to west, the finest soils of the whole world are found in places such as western Iowa and southeastern Russia.

The Use of the Soil

Unwise Uses. Since all life depends on the soil it is obviously of supreme importance to preserve or renew its fertility. In a state of nature most plants die where they grow. The materials which they contain are thus returned to the soil through decay. Moreover, there are usually many varieties of plants on the same area, so that the same kind of food is not demanded by all. On farms, on the contrary, it is usually necessary to

devote the whole of a given area to a single crop at any given time. When the crop is reaped, it is carried away and consumed somewhere else. Thus there is a great drain on the soil. For example, many early settlers on the great plains of our central and western states wanted to get rich as quickly as possible. Accordingly, they planted wheat year after year, selling the grain and burning the straw. Thus they returned practically nothing to the soil. At first the crops were abundant, but soon the soil began to shows signs of exhaustion, the crops fell off, and the value of the farms declined. The settlers forgot that one of their duties was to see that the fields were passed on to their descendants in good condition. In the southern states many farmers have injured their lands by constantly planting tobacco, which speedily exhausts the potash of the soil, or cotton, which does the same thing more slowly. These crops bring good prices and are an easy way of getting ready money, but such one-crop farming, which sells the fertility of the soil along with the crop, is like killing the goose that lays the golden eggs.

Wise Use of the Soil. (1) ROTATION OF CROPS. The wise farmer lessens this drain on the soil in two ways: (1) by rotation of crops, and (2) by using fertilizers. Rotation of crops means that the farmer plants different crops from year to year, so that on a given area the same elements are not constantly required in large amounts. It is called rotation because after a few years the same series of crops is planted over again. In planning a rotation the object is not only to use crops which do not require the same food, but to include some, such as buckwheat and clover, which can be plowed under to serve as fertilizer. For instance, beets need a great deal of potash, while wheat in proportion to its bulk requires only half as much, but needs nearly twice as much nitrogen. Clover, and peas, on the other hand, do not require much nitrogen from the soil. Indeed their bacteria actually take nitrogen from the air and give it to the soil. Hence beets, wheat, and peas would make a proper rotation.

The rotation of crops has still another value, as the people who raise cotton found out in the early part of the first World War. As England prevented the shipment of cotton to Germany and Austria, the market for the crop was restricted and the price fell very low. As the farmers had no other important crop to sell, many could not pay their debts, even though they had large supplies of cotton. If they had practiced rotation of crops, they would have had fields of corn, beans, peanuts, and sweet potatoes. These could have been sold at good prices and thus have supported the farmers until cotton again rose to a profitable price. In 1915 they began to learn this lesson, and planted more corn than before. The rotation of crops also helps in checking the ravages of insects and of bac-

terial plant diseases. Wise farmers find that a variety of crops is as valuable in peace as in war.

(2) USE OF FERTILIZERS. The use of fertilizers is as important as the rotation of crops in preserving the fertility of the soil. The southern farmer who raises cattle and hogs as well as corn and cotton can do this without great expense. The seed from his cotton, after the oil has been extracted, makes good food for cattle, and corn is the best of food for pigs and hens. Thus much of the nutriment taken from the soil by the crops can be returned in the form of manure. The Chinese not only return to the soil all the waste products of animals, but also human waste and sewage which we permit to pollute our rivers and harbors. By such means they have maintained high fertility for thousands of years. Inevitably, however, if some of the products of a farm are sold and are consumed elsewhere, there is some loss of fertility each year, even though there is a wise rotation of crops and many animals are raised. If this loss is more rapid than the freeing of new materials through the weathering of the soil, as is often the case, the soil becomes steadily poorer unless artificial fertilizers are employed.

The Need of Chemical Fertilizers

What Chemicals Plants Need from the Soil. In order to provide the right kind of artificial fertilizers it is necessary to know (1) what chemical compounds plants need, and (2) how much of these the soil contains. Plants take at least fifteen chemical elements from the soil. Silicon, chlorine, sodium, and manganese are of slight importance and seem almost always to be present in sufficient quantity. Magnesium, iron, sulphur, copper, zinc, and boron must be present in a soluble form that can readily be absorbed by the plants. The farmer rarely needs to worry about these, however, for they are practically always present in sufficient abundance for any kind of crop. Calcium, phosphorus, potassium, and nitrogen, on the contrary, often cause much trouble because they are not available in sufficient quantities. The absence of cobalt or nickel may cause grasses and vegetables to be poor food for animals and man.

How the Farmer Knows What Kind of Fertilizer to Use. The following table shows the amount of the chief elements used by an acre of beets each year, in a mild, moist climate of middle latitudes. It also shows the amount of each in the upper part of an ordinary loamy soil, and the number of years that the element would last if the beets could get every bit of it. Evidently the farmer who is raising beets needs to provide fertilizers rich in potash and nitrogen rather than in phosphorus and calcium. It must be remembered, however, that the process by which nature prepares the ingredients of the soil is slow. Hence if beets are raised each

year they exhaust the available supply while large reserves are still waiting to be prepared. Even after five or ten years, unless fertilizers are applied, the available nitrogen will be so scanty that the crop will not be worth raising. In other kinds of soil, some of the other chief elements may be exhausted. For example, in a sandy soil, the plants are stunted for lack of lime (calcium carbonate).

RELATIVE AMOUNTS OF IMPORTANT INGREDIENTS IN AN ORDINARY SOIL

A Soil Ingredients	B Amount Used Each Year by an Acre of Beets, pounds	C Amount in Upper Foot of an Acre of Loam, pounds	D Number of Years That Ingredient Would Last if Whole Supply were Available
Calcium in the form of lime	43	54,000	1260
Phosphorus in the form of phosphoric acid........	53	12,800	240
Potassium in the form of potash................	300	23,000	77
Nitrogen in the form of nitrates and ammonia...	149	7,000	47

Artificial Fertilizers

(1) *Lime.* In searching for fertilizers other than manure, it is necessary to find materials which are not unduly expensive and which will furnish lime, phosphoric acid, potash, and nitrogen in forms that the plants can readily assimilate. Lime presents no special difficulty. Almost all the main agricultural parts of the world contain limestone beds, and it is merely a question of finding the cheapest means of grinding the rock and making it easily accessible to the plants.

(2) *Phosphates.* Phosphates are not so easy to find, but may be obtained from five chief sources: (*a*) They occur abundantly in a few minerals such as *apatite.* These are generally so intermingled with quartz, feldspar, and other materials that it is difficult to prepare the phosphates as a fertilizer, and they are little used. (*b*) Another source of phosphates is great beds of *guano,* or bird droppings, on several dry islands of the South Pacific and West Indies. From 1830 to 1880, guano worth about $600,000,000 was taken from the Chincha Islands off the coast of Peru and carried around Cape Horn to be sold in Europe and America at $30 to $60 per ton. The Peruvian government was largely supported by the taxes on the guano until the deposits were exhausted. Only a limited amount is now available, in spite of the millions of birds that fly low over the sea for hours on their way to and from the fishing grounds.

(*c*) The easiest source of phosphates is the slaughterhouse, from which the bones and refuse of domestic animals are taken to ill-smelling fertilizer plants. In former years bone-hunters drove their wagons over our western plains gathering the skeletons of buffalo and cattle that had perished in blizzards, by the wolf pack, or at the hand of the hunter. (*d*) Today the world is drawing on ancient geological deposits of animal

A—A Phenomenal Corn Crop Raised by Boys. This shows what can be done if the soil is properly enriched and cultivated.

bones and refuse in the form of phosphate rocks. The chief supply comes from Florida, South Carolina, and Tennessee, and especially from Tunis and Algeria, but some is available in Montana, Idaho, Utah, and Wyoming.

(*e*) The fifth source of phosphates is very modern and is found near coal beds in advanced countries such as England and Germany where much iron ore is smelted in blast furnaces. Many iron ores contain phosphorus, and it is left in the slag which remains in the furnaces after

the molten iron is drawn off. The main part of the slag is lime. Hence when it is ground up it makes good fertilizer.

(3) *Potash.* The United States has had much more difficulty in getting potash than phosphorus. Before the first World War the only largely worked deposits were those already mentioned at the Prussian town of Stassfurt, and some others in Alsace where the French and Germans were fighting. During the war high prices and the danger that the supply would be cut off led the United States government to search for new sources. Production began at several salt lakes, especially in the dry western part of Nebraska, whence most of the limited American production now comes. Kelp, too, was gathered along the Pacific Coast, and potash was extracted from the dust of cement mills and blast furnaces.

There does not seem to be much prospect that large new supplies of potash will be discovered. Only a few dry salt lakes are like Searles Lake in having considerable potash mixed with their common salt and other saline materials. At Searles Lake the salts were deposited as crystals by the drying up of a large lake whose traces are still seen in numerous shorelines at high levels. When potash was being extracted here, the brine was pumped from wells 75 or 100 feet deep and evaporated until the potash crystallized out. The Dead Sea in Palestine contains billions of pounds of potash. This will some day probably crystallize into deposits like those of Stassfurt unless people take it out by evaporating the water. The farmers need this potash to replace that which they send to market in the form of meat, wheat, and other food supplies.

(4) *The Search for Nitrogen.* Among the essential ingredients of the soil nitrogen is much the hardest to obtain. Its original source is chiefly the air, where the supply is inexhaustible. Until recently, however, this was almost useless to the farmer, for no one knew how to convert it into a soluble compound that could be carried into the roots of the plants by water. This is because nitrogen is one of the most inactive chemical elements. Quite unlike such an active substance as oxygen, it will not readily unite with other elements.

Because of this the Atacama Desert in northern Chile long had a unique importance. It contains the only known large deposits of compounds of nitrogen. Before their value was known, the Atacama Desert was such a barren waste that no one lived there, although Chile, Peru, and Bolivia all laid claim to parts of it. When the value began to be appreciated, however, about 1879, all three countries wanted it. This led to a long war in which Chile was the victor. Then followed a period when the nitrate fields were exploited to the value of $50,000,000 each year. The taxes paid by the British companies that work the nitrate fields were long one of the chief sources of the revenue of the Chilean government.

Today these natural supplies of nitrates, though much diminished, are still important.

One interesting result of the prolonged search for sources of nitrogen has been that scientists have found that the bacteria that cause "nitrification" can be raised artificially and shipped anywhere. When clover seed is inoculated with them the roots become covered with unusually large tubercles which contain nitrogen, and thus the fields are fertilized.

Another interesting result of the demand for nitrogen fertilizers was first seen in Norway. After the value of nitrates was realized people began to search for means of utilizing the unlimited supply of nitrogen in the air. Success was at last obtained by means of strong electric currents which cause the atmospheric nitrogen to unite with lime or other substances. Much power is required for the electric discharges, so that the process is commercially profitable only where power is cheap. The cheapest known source of power is waterfalls, which are especially abundant in rugged Norway. Since raw materials of most kinds are not abundant there and nitrogen is present everywhere the manufacture of nitrogenous fertilizers has become an important industry. Nevertheless, this is now far from being the main source of nitrogen fertilizers. New processes using cyanamide, ammonia, and distillates from coal have been devised. So now the greatest source of nitrate fertilizers is found in Germany and other manufacturing regions.

The work of obtaining fertilizers from old bone deposits, from desert lakes, from the air, and from coal may seem remote from the lives of people who live in cities. Yet it concerns every one of us. The farmers supply us with most of the materials for the food and clothing which play so large a part in the lives of all of us. If the farmers do not have rich soil and cannot raise their crops abundantly and cheaply, the price of food and clothing goes up, and we all suffer. Therefore, it is of the greatest importance that the farmers' need of good fertilizers should be fully met.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Examine the soil of a number of gardens and farms and classify it according to color as well as texture. What relation, if any, do you find between the color of the soil and the quality of the crops?

2. Find out what schemes of rotation of crops are used on the farms in your neighborhood. How and why does the rotation differ on different kinds of soil?

3. In Germany and northern France, the raising of sugar beets is nearly always connected with stock raising. What advantages and disadvantages has this from the standpoint of soil.

4. At the docks at Liverpool, tramp steamers from Argentina are sometimes seen unloading cargoes of bones. Why do the bones come from Argentina? Why are they sent to the United Kingdom?

CHAPTER XIV

METALS AND CIVILIZATION

Why Minerals Are Most Abundant among Mountains

The processes of mountain building are closely connected with the occurrence of metals. If the earth's intermittent contraction had not bent and broken the crust, and caused molten materials to move from lower to higher levels, many minerals would be practically unknown. Metals, which are the most valuable minerals, are heavy. Iron weighs three and gold seven times as much as quartz. Consequently during the earth's cooling the metals seem largely to have sunk into the interior. We infer this from the fact that the earth as a whole weighs twice as much per cubic foot as does the outer mile or two of the crust. If no mountain building had ever taken place the heavier minerals would probably now be almost entirely buried far beyond our reach.

Mountains have also been a help because their height and slope have permitted erosion to cut deeply into the earth's crust. Otherwise most of the metallic deposits, even though uplifted, would be buried under an enormously thick layer of dense rock. During the lapse of millions of years the work of running water has carried away thousands of feet of rock and exposed many deep-seated deposits. An immeasurable quantity of valuable minerals has thus been carried to the sea as mud and lost, but in doing this the underlying rocks have been exposed so that at least a part of the earth's metallic wealth is accessible.

Because of all this, mining industries are largely concentrated in regions of rugged relief. In the United States the chief mining regions are in the Sierra Nevadas, the Rocky Mountains, and the Appalachians. The mountainous relief of Arizona is one of the factors in its annual production of minerals usually worth well over $100,000,000, or more than $250 for each inhabitant. In the same way mountainous Montana often produces over $150 worth per inhabitant. Texas, on the contrary, aside from its enormous production of petroleum and natural gas, produces minerals worth only $2.50 to $3 per inhabitant. The state consists largely of plains, and petroleum is normally a product of regions of low relief. The figure for the flat State of Mississippi is only 70 cents. None of the mineral wealth of Mississippi is metallic.

In some places, such as the Lake Superior district, with its iron and copper, a mineral region presents almost the gentle relief of a peneplain, but folded rocks within the gently rounded hills still show that mountains of rugged relief once existed here.

Mineral fuels, unlike most of the metals, are found in plains or lowlands, as well as in rugged regions. Coal is mined extensively in Illinois and Ohio as well as among the hills of western Pennsylvania. Among mountains, such as those of eastern Pennsylvania, the coal has occasionally been so folded, heated, and pressed that it is changed from the soft, bituminous form to the hard form known as anthracite.

Petroleum occurs almost entirely in regions where there has been little disturbance of the rocks. The world's great oilfields are often found in plains like those of California, Oklahoma, and Mexico. If the rocks are much fractured, the petroleum with the accompanying natural gas is almost sure to escape.

Stages of Mining Industries

(1) *Prospecting.* The influence of metals upon the geographical distribution of human activities is exerted in two distinct ways. One is connected with the work of discovering and mining them, and therefore is located mainly in mountainous and other remote parts of the world. The other is connected with their use, and therefore is located mainly in the most advanced industrial regions. The work of discovering where metallic ores are located is called prospecting. Even in these days of modern science it still is often carried on by solitary men who wander for months among the mountains. Even in highly civilized regions, such as Arizona or Montana, one may still meet an unkempt, unshaven prospector driving donkeys laden with a camp outfit, or perhaps with samples of rock to be "assayed" or tested. For months he has been camping alone and spending his days prowling among the mountains in search of rock that looks like good ore. Now and again he leaves a "location" paper in an empty tin can on the end of an upright stick, to declare that he *claims* a particular *location*. If the ore there proves valuable, he will file the necessary documents with the government.

The lonely and often dangerous life of the prospector makes him hardy and resourceful. He is so glad to see a new face that he is extremely open-hearted and hospitable not only to his comrades, but even to strangers. In spite of these good traits, prospectors rarely prosper. All their dangers and hardships seldom result in riches, or even in a good living. One trouble is that on their rare visits to town they usually waste their money on gambling and dissipation. Another is that, when they make a real find, money comes so easily that they promptly spend it,

thinking they can quickly get more. The growth of modern geology has caused this ignorant type of prospector to give place to the trained expert who lives in the lowland cities and makes occasional expeditions to the mountains.

(2) *Development.* After a promising prospect has been located, it is "developed," sometimes by the prospector, but usually by lowlanders who can furnish the necessary capital. "Development" consists of exposing enough ore to see whether its quality and abundance warrant the installation of permanent mining machinery. Roads must be constructed to bring supplies and carry the ore to places where it can be smelted; shacks must be built; miners must be hired. Where much development is going on the typical smaller mining "camps" of our western mountains grow up. Few families settle there, for the work may end any day. The poolroom and dance hall are usually the main social centers. Wages are high; the stores charge exorbitant prices; and the miners spend their money freely. Such a camp is full of the evil influences that go with a life where men wander from job to job, and there is little in the way of families, churches, and other institutions to keep them steady.

MINING BOOMS. When mines are being actively developed among the mountains, "booms" are likely to be launched in lowland cities. The owners of a valuable prospect must replace their rough trails by good roads or railways, they must erect stamp mills to crush the ore, and smelters to melt it and separate the metal from the impurities. In order to attract capital they print glowing advertisements telling how rich and abundant is the ore and how quickly investors will grow wealthy. Often the promoters of such a prospective mine really believe what they say, but are mistaken. Equally often, unscrupulous promoters tell big stories without regard to the truth. Rarely do investors in mines that are publicly boomed recover even the money that they put in, and much less make a profit. Generally if the prospects are really good, there are plenty of people to supply the capital without much advertising.

(3) *Permanent Mining.* Most mining ventures never get beyond the stages of prospecting and development. The few that survive may give rise to relatively permanent industries. Iron ore, aluminum-bearing rocks, and coal beds frequently occur in such abundance that work can be carried on in the same region for generations. The coal beds of Wales, for example, have yielded a vast supply of fuel for more than a century. In the United States the enormous iron deposits of the Lake Superior district began to be worked extensively soon after 1880, but show little sign of exhaustion. The precious metals, on the contrary, are usually found in small veins which may suddenly come to an end without warning. The same is true of copper and lead, but to a less degree. Petroleum deposits

are also likely to diminish rapidly. Few wells flow more than ten years.

The Precious Metals

(1) *Placer Mining*. The precious metals may serve as an example of the stages of the mining industry. Gold occurs in such a form that it particularly encourages prospecting. When found in small flakes or nuggets in "placers," that is, in gravel deposited by running water, it can be recovered very easily. The gravel may be placed in a large pan with water and swirled about so that the water and gravel gradually spill out. The gold, being heavy, stays at the bottom of the pan. Hence anyone who can pay his way to the mining region can engage in gold mining. There is always the chance of coming upon a pocket of gold dust or nuggets and becoming rich in a day.

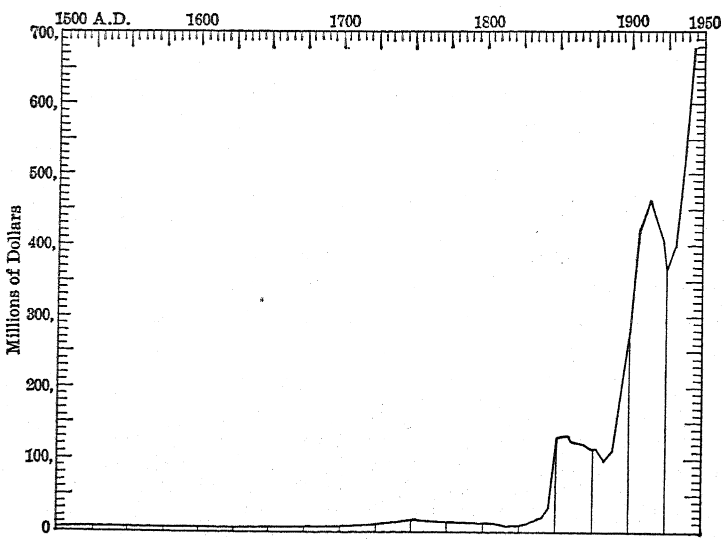
When the news of the great gold deposits of Klondike became known in 1896, miners and adventurers from many lands toiled across the bitterly cold mountains of Alaska. Everyone was so feverishly anxious to "make his pile" that almost no one was willing to do ordinary work such as cooking, house-building, store-keeping, and road-building. Hence wages rose to five or ten times their usual level. Since the cost of carrying a ton a mile over the mountains was about $20, the vast majority of the 30,000 people who penetrated the region had to spend most of their earnings for food and lodging. The production of gold increased rapidly for a few years as is shown in A302, but soon declined. This is typical of most mining ventures. So, too, is the way in which most of the miners returned home as poor as when they came.

One of the latest mining rushes has been directed towards the radium deposits of northern Canada. Although prospectors now travel to the mining regions in airplanes, the search for minerals on the ground, and the spirit of extravagance are still much the same as ever.

(2) *Hydraulic Mining*. A302 shows that, after the peak in 1900, gold production in the Yukon district declined most of the time until 1925. It went up, however, during the first World War because of new methods. By the hydraulic method, for example, great streams of water are shot against the gravel banks of the "placers." The water carries the gravel into sluices where the heavy gold lodges in corrugations like those of a washboard. In California hydraulic mining has stripped the bottoms of many mountain valleys to the naked rock; the gravel has been washed downstream where it has converted fertile alluvial plains into deserts of small stones. Where there is sufficient water, as along the Sacramento River in California, great floating dredges scoop up the gravel and extract the gold. Such a dredge digs its own channel ahead of it, and fills the space behind itself with great heaps of washed pebbles and cobble stones.

(3) *Mines in Solid Rock.* The gold of placer deposits comes originally from veins in solid rock. There—far underground—hot mineralized water long ago deposited it as thin plates or scattered bits in the midst of such minerals as quartz. After the excitement of a new gold field is over, prospectors begin to search for exposed veins from which the placers may have derived their gold. Then comes the more permanent stage of mining. The process of getting either gold or silver from the solid ore which contains the veins demands much capital and is impossible for the ordinary miner. Large companies are formed and towns grow up.

A good sample of such a town is Virginia City in Nevada. At first the ignorant miners there searched only for gold, and threw away a black



A—Gold Production of the Yukon District in Canada.

silver ore which formed the great Comstock Lode, the richest of the world's great ore deposits so far as yet known. From 1859 to 1880 the Lode produced metals valued at $305,000,000. In 1877 the value was over $36,000,000. At that time Nevada alone produced more gold and silver than all the rest of the United States. Virginia City prospered and became a city of 11,000 people, although its food, timber, and other supplies had to be hauled up steep mountain roads to a height of 6,200 feet. Although the town has at certain times revived somewhat because of the consolidation of properties and the discovery of more ore, Virginia City is typical of what happens when veins of precious metals become exhausted. For years the streets have been almost empty, the hotels boarded

up, most of the houses untenanted and falling to ruin, while fine schoolhouses stood abandoned. Today there are scarcely 400 people within the limits of the former city.

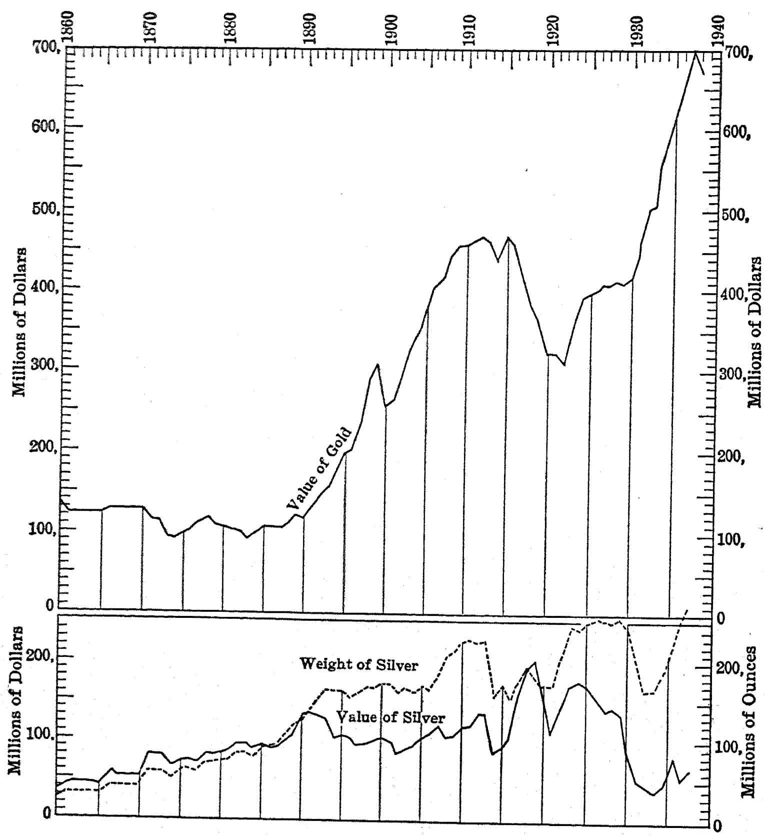
Economic Importance of Gold and Silver

Although gold and silver are not one thousandth as useful as iron in the arts and sciences, their attractive qualities have given them a tremendous influence on the geographical distribution of human activities. In primitive days much of the exploration and settlement of new regions is supposed to have resulted from the search for gold. One of the chief reasons why Columbus received help from Ferdinand and Isabella was their hope that he would find gold. The conquest of Mexico and Peru by the Spaniards was also largely due to the hope of finding large stores of precious metals. One of the reasons why Spain became so powerful after the discovery of America is supposed to be the great influx of gold from the new world. In this case as in many others, the gold had an influence not only upon the people who mined it, but later upon the people of another land into whose hands it fell.

In modern times the same thing has happened in a somewhat different way. Before the first World War gold had become the single standard of value in practically all countries except China. This has caused great trouble. In the first place, recent years have seen great changes in the demand for gold, partly because business is more and more carried on by checks and drafts, and partly because many countries no longer attempt to make gold the standard of their money. Hence no one knows how much an ounce of gold is really worth. Gold tends to flow to the more prosperous nations. Therefore, by the time of the second World War most of the world's supply was in the hands of France, Great Britain, and especially the United States. For years before that a steady stream of gold flowed to this country. Inasmuch as it was no longer used as currency, the government did not know what to do with it. Hence vast quantities were stored in great vaults underground in Kentucky far from danger in case of war. No one knows whether the production of more gold is an advantage or not. Many economists think that it should be given up as the standard of value for money. They advocate a new standard based on goods of all kinds and so framed that a given income will support the same standard of living year after year without the ups and downs that are now so troublesome.

The production of too much new gold tends to lower the value of the old gold. This means, of course, that prices go up because it takes more gold to pay for a given article, such as a suit of clothes. Since 1920 the world's production has doubled and now amounts to more than a billion

dollars a year in United States money. The greatest production still comes from South Africa where the Witwaters field is believed to contain 20 billion dollars' worth of gold. By far the greatest increase has been in the wild, cold forests of northeastern Siberia. There the production is far greater than in either the United States or Canada, which come next as producers, and it is still increasing rapidly. Since the Russian



A—World Production of Gold and Silver since 1860.

economic system does not need gold, or any other metal, as a standard for money, all the Russian gold is exported and most of it comes to the United States. This happens because our geographic environment makes us the richest and most prosperous nation in the world. Some economists think that, having gathered all this gold, we shall be left with it on our hands when its value as a standard of money disappears. In a region

such as northeastern Siberia the production of gold is one of the dominant facts in the life of the people, whereas in a rich manufacturing country such as the United States the problem of exchanging our raw materials and manufactured goods for the gold of other countries is of the utmost importance. Our gold may help us to continue to prosper but no one can be sure that the opposite result may not occur.

The Rôle of Iron

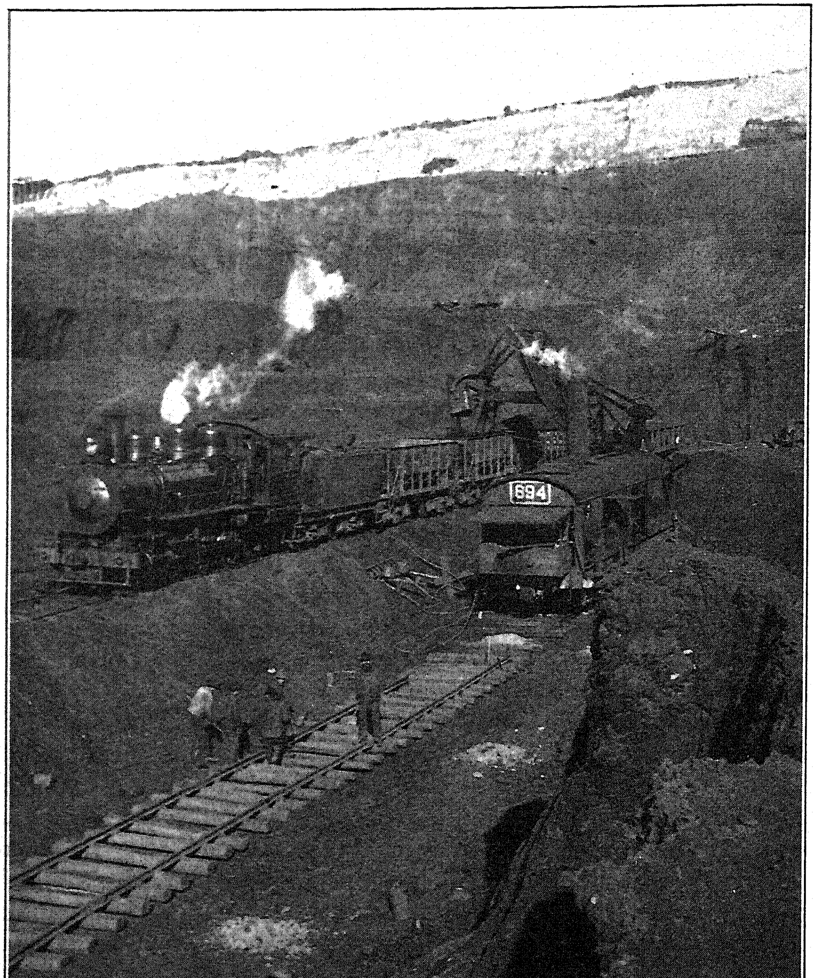
If all the gold and silver in the world should be destroyed, man's activity would go on almost unchanged, but if iron should be taken away, our mode of life might be even simpler than that of the first colonists in America. One reason for the widespread use of iron is that its ores are found in most parts of the world. It is not the most common metal, however, nor is it the easiest to separate from the ore. It forms 4.6 per cent of the earth's crust, whereas aluminum forms 8.2, and calcium 3.5, magnesium 2.6, sodium 2.6, and potassium 2.4 are only a little less abundant. None of these, however, is used to any such extent as iron. Even in the case of aluminum the annual production is only 1 ton for every 200 or 300 of iron.

The chief reason for the universal use of iron is its peculiar properties, especially (1) its capacity for assuming many different forms, such as cast iron, wrought iron, magnetic iron, and innumerable forms of steel, (2) its strength, (3) its hardness, (4) its ductility or capacity for being drawn into wire, and (5) its magnetic properties. Because of these qualities iron is the universal material for tools and machines, and thus becomes one of the most important factors in promoting civilization.

Scanty Iron and the Character of Early Civilization. The amount of iron used in any given part of the world, or at any stage of the world's history, gives considerable insight into the character of the civilization. Although the ancient civilizations of Egypt, Palestine, Mesopotamia, Greece, and Rome rose to a high level, they were bound to be very different from ours because they used little iron. In phases of civilization such as art, literature, philosophy, religion, and government, in which mineral resources play only a small part, the people of ancient times made great progress, and in many ways excelled the nations of today. In other phases, such as manufacturing, transportation, commerce, and mining, where complex machinery plays an important part, they made little progress and were in about the same stage as modern China outside its few industrial cities. This difference is due to the fact that the use of iron, as well as of timber, coal, and mechanical power, did not develop until the center of civilization had moved northwest to the regions surrounding the North Sea. One reason why it did not develop earlier was probably the scarcity

of iron ore, forests, coal, and easily available waterpower in the climatic regions adapted to the earlier and simpler stages of civilization.

Iron ores do not occur in plains such as those of Egypt, Mesopotamia,



Keystone View Co.

A—Iron Mining by the "Open Pit" Method at Burt on the Missabe Range in Minnesota.

northern India, eastern China, and Guatemala, where the world's earliest civilizations developed. Nor are such ores abundant and easily obtained in limestone countries like Syria and Greece. Italy also has only a little iron, and most of that comes from the island of Elba. Thus practically

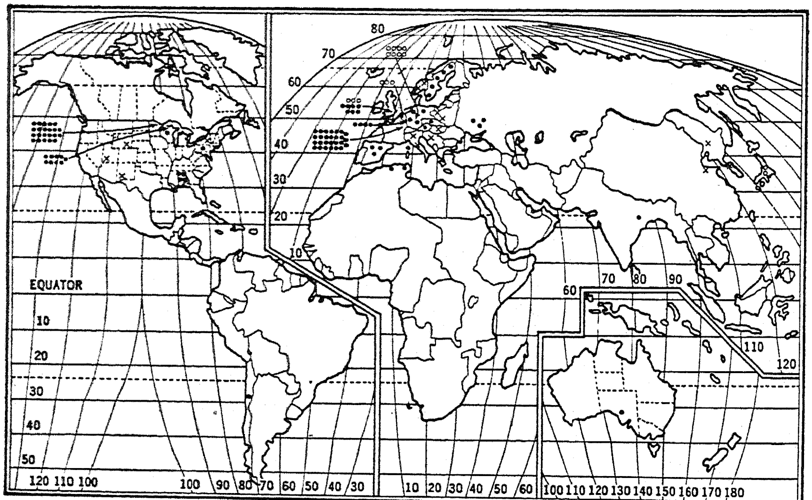
all the great countries of antiquity are deficient in natural supplies of iron. Coal, too, is scarce or absent in all these countries except China. Moreover, in these countries and also in some outlying regions where ore is found, for example Asia Minor and the Libyan Desert, there are comparatively few trees, and thus the smelting of iron was greatly hampered. With their small and expensive supply of iron, the civilized people of early times made only such small tools as knives, hoes, and weapons. Simple machines such as the steam engine of Hero of Alexandria, who lived before the time of Christ, and the hand loom which was widely used, had indeed been invented, but could not be extensively developed for lack of iron.

Abundant Iron Deposits and the Character of Modern Civilization. Modern civilization, unlike ancient, is located in places where it is easy to procure both iron and the fuel to smelt it. The most energetic races dwell in countries such as northern Spain, France, Belgium, Germany, England, and Sweden, which contain abundant iron ores and are naturally covered with heavy forests. Hence when the northwestward march of civilization into cooler and more stimulating climates caused these regions to emerge from barbarism the use of iron increased. People were able to use it freely for such purposes as armor, nails, and plows, for which it had previously been too expensive. In the days of Queen Elizabeth the demand for iron became so great that laws had to be passed to prevent the forests from being wholly consumed as fuel in iron furnaces.

At this stage another geographical condition became important. England, northern France, Belgium, and Germany contain great deposits of coal located close to the iron ore. In England, soon after A.D. 1700, people discovered that by converting coal into coke they could get rid of the sulphur in the coal, and use it for smelting. The rapid adoption of this method so increased the available supply of iron that such machines as the steam engine could be turned out in large numbers. The ability of modern civilization to use iron for tools and machinery is one of the chief causes of the contrast between ancient and modern civilization. Ancient civilization put the emphasis on art, literature, philosophy, religion, and government; modern emphasis is on science, on man's material betterment, and on the use of natural resources through manufacturing, transportation, commerce, and mining. We may hope that the civilization of the future will place equal emphasis on the idealism of the ancients and the materialism of the present.

Where Iron Ore Is Most Favorably Located. Countries such as the United States, England, Germany, and France, where coal and iron are both abundant, have a tremendous advantage. Countries such as Sweden and Spain, which have plenty of ore but little coal, lose much of this

advantage. They have to send the ore to places such as England and Germany which are well supplied with fuel. This is cheaper than to take the coal to the ore, for about two tons of coal are needed to smelt a ton of iron ore. It must not be supposed, however, that coal and iron, either separately or together, provide the main cause of the development of modern civilization. That had reached nearly its present geographical distribution before either coal or machinery came into anything more than the most elementary use. These minerals were, however, most potent factors in stimulating the growth of modern civilization and especially in turning it into its present mechanical course.



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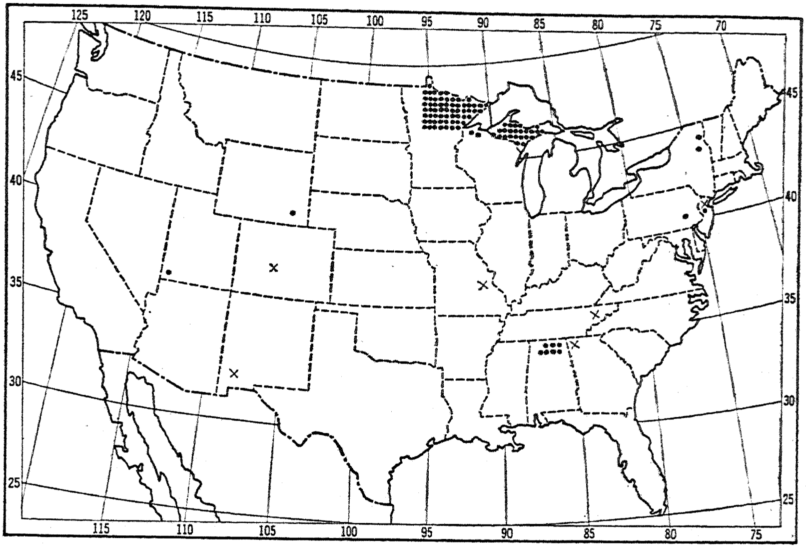
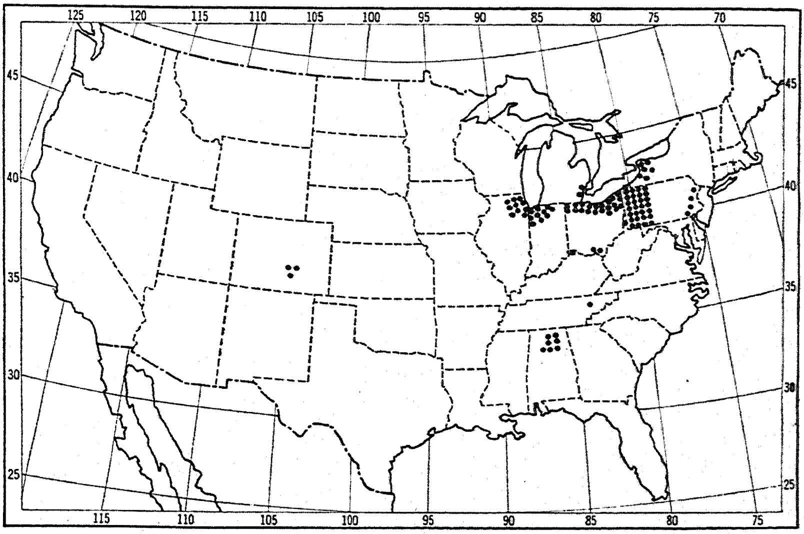
A—World Production of Iron. Each solid dot represents the mining of ore yielding 1 per cent of the world's annual production of iron. Crosses indicate minor production. Each open circle indicates importation of ore which after smelting yields 1 per cent of the world's production.

Our own country is particularly favored because it has enormous deposits of both coal and iron. They are, to be sure, at a considerable distance from one another, for the best coal beds center in Pennsylvania, while the best and largest iron deposits are in the Lake Superior region (A322 and A308). For most of the distance between the two, however, there is cheap transportation by the waterway of the Great Lakes, and the ore can easily be carried to the fuel. Moreover, the coal is near the center of the great market of the northeastern United States, so that after the ore is made into iron it does not have to travel far before being used. During the first World War, while the other great iron-producing countries were fighting, the mining of iron in America increased as never be-



A—Annual Value of Iron Ore Produced in the United States. Each dot indicates 1 per cent; crosses, minor amounts.



B—Distribution of Blast Furnaces in the United States.

fore. The excellence of both the coal and the ore in the United States will probably help the country to maintain the leadership in the iron industry which it then obtained. Over 90 per cent of the world's annual production of 1,700,000,000 tons of metallic ores and fuels consists of coal and iron, and a third of this is mined in the United States. Soviet Russia, Germany, and Great Britain come next as producers of iron.

The United States Steel Corporation. Since iron is the most important of the materials used in manufacturing, and demands large-scale methods of smelting, it has led to industrial combinations of enormous size. The great German steel combine controls practically the entire steel business in Germany and was long the largest business combination outside the United States. The United States Steel Corporation, however, is even larger. It has reached its present size because economy demands that a great number of operations in different places should be performed under one management. In producing pig iron it is necessary first to have great ore beds in the Lake Superior district or elsewhere. Next the ore must be carried by lake and rail to a coal region such as Pennsylvania. Coal must be mined and converted into coke and then brought to the factory, while limestone to be used as a flux must also be quarried. Notice in B309 how the blast furnaces skirt the southern shore of the Great Lakes where coal brought by rail can most easily meet iron ore brought by steamer. When a single company owns mines, quarries, steamships, railroads, coke ovens, blast furnaces, and factories it saves a great amount of loss through faulty cooperation, especially in a business where storage of materials is expensive, and a shortage of any one disastrous.

Because of such advantages the United States Steel Corporation today controls half the steel business of the United States. In good years it employs over 250,000 men, distributed from Alabama to Lake Superior and from Pennsylvania to Colorado. Its 150 great manufacturing plants, 130 iron mines, 750,000 acres of coal lands, 1,300 miles of railway, 1,400 engines, 60,000 freight cars, and 100 steamers, together with its docks, limestone quarries, gas wells, and oil wells, are worth 2 billion dollars, and often yield a profit of 100 or even 200 million dollars each year. A part of the profits, but not enough, as some people think, has come back to the public. For instance, Andrew Carnegie, for a long time the largest stockholder of the Corporation, gave not far from 350 million dollars for public use in libraries, scientific organizations, educational institutions, and many other forms. This is the only right course, for the profits of all such industries, although due in part to wise management, are also due partly to the fact that our laws permit private individuals to obtain control of valuable natural resources like coal and iron.

How Copper Influences Human Progress

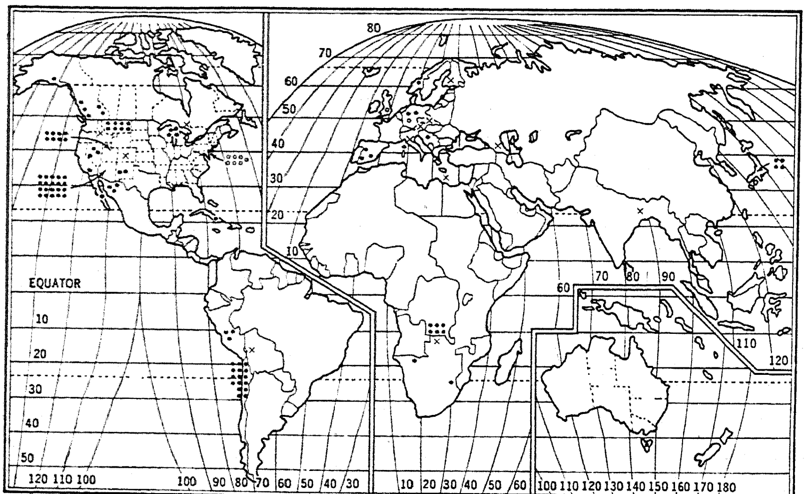
After iron tools came into use at the end of the Bronze Age copper played a minor role, its chief use being for cooking vessels. Within the last half century, however, copper has again become important, for the world has learned to use electricity. Among all the common substances copper is the best electrical conductor. Therefore no power plant, telephone, automobile, or electrical machinery is made without copper. In California and elsewhere copper wire now makes it possible to transmit electric power a thousand miles. The need of good electrical conductors is growing so rapidly that copper deposits are being exploited on a large scale in places such as Chile and Belgian Congo far from the regions where the copper is used. Eight times as much copper was produced in 1910 as in 1880, and there has been a steady increase in more recent years. The world's production is now well over a million and a half tons per year.

Copper Production of the United States. The United States is the chief factor in the copper situation, for it produces nearly half of the world's supply, and buys a great amount elsewhere. It is the only great industrial country, aside from Japan, that has large copper mines. The American supply formerly came largely from the Upper Peninsula of Michigan, but now Arizona supplies three or four times as much. Oddly enough the fact that the ore in Michigan often occurs in large pieces of pure metal is a disadvantage. Copper ore can be smelted more easily than pure copper can be dug out, for the metal is so ductile that it cannot be broken by blasting. Arizona and Montana are now the chief copper states, but the metal is used chiefly in the northeastern quarter of the country, especially Connecticut (A312). Hence much of it travels to its destination by way of the Panama Canal.

The Character of a Copper Town. The demand for copper has led to the growth of many cities such as Butte, Montana, and Bisbee, Arizona. The surrounding regions have been thoroughly prospected and the copper industry has assumed a permanent aspect. Hence the towns have lost many of the bad qualities of the "boom" towns which grow up where the precious metals are mined. A man may settle in a copper-mining town with the idea of staying there for life. The chief drawback is that mining is a hard, disagreeable occupation. Aside from the skilled superintendents, engineers, and foremen, it usually attracts a relatively poor kind of labor. Moreover, most of the copper mines are not located in agreeable surroundings, for the bare deserts of the region west of the Rocky Mountains are less attractive than more fertile regions elsewhere. Another drawback is that the smelting of copper ore fills the air with

vast clouds of sulphur, for many of the best ores are a combination of copper and sulphur. At Butte, Montana, and other places, the sulphurous smoke is carried to heights of 400 or 500 feet in great chimneys. For a long time, Butte, like Oroya in the Peruvian Andes, and some of the Japanese copper camps, was a place where the smoke settled down in such volume that not a tree could grow within miles of the smelters. The situation is better there now. Nevertheless, such conditions often drive capable people away from mining towns, and thus retard them still more.

Copper in Other Countries. Other countries where copper is abundant are Chile, Northern Rhodesia, Belgian Congo, Japan, Soviet Russia,



Goode's Semi-homolosine Equal Area Projection.

A—World Production of Copper. Note the open circles indicating imports through New York, largely for use in Connecticut.

Spain, Mexico, and Australia. The Chuqicamata deposits in Chile, owned by an American corporation, and those of Katanga on the tropical plateau of southeastern Belgian Congo are among the largest in the world. Copper is one of Japan's chief metal products, but her annual production is often less than one-tenth that of the United States. Aside from Spain the countries of Europe have little copper. In the Balkan Peninsula and Asia Minor, supplies exist, but are not extensively worked. Germany's inability to get copper during both World Wars was a great handicap. Ordinarily that country produces only 26,000 tons a year and consumes about 260,000 tons. In wartime her need is vastly increased. The government requisitions every available bit of copper, including trolley wires, electric light fixtures, faucets, old tea kettles handed down for generations,

and the very roofs and bells from the churches. In the first World War even the Emperor's palace was not spared, and attempts were made to buy up the copper coins of neighboring countries, such as Norway, Sweden, and Switzerland.

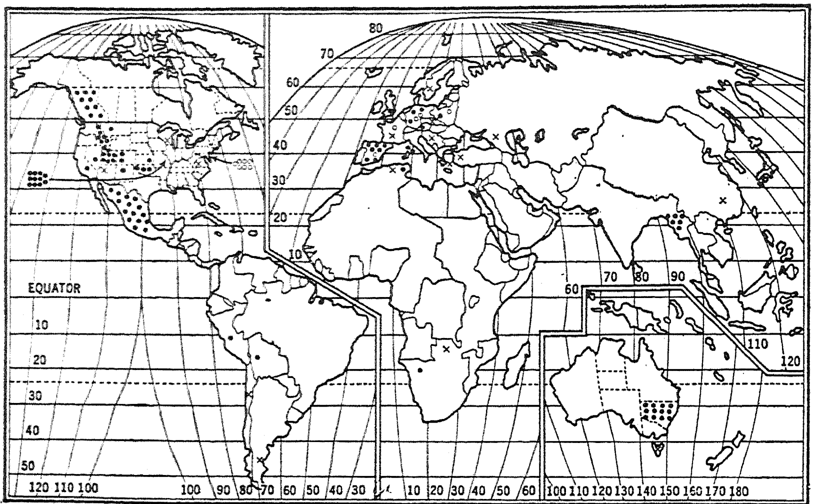
Aluminum

The light metal known as aluminum is a comparative newcomer. Not until about 1910 was it sold at such a price that it could be used like iron and copper for ordinary purposes. Its uses lie between those of the other two metals. Pound for pound it surpasses copper as an electrical conductor, but cannot so easily be made into wire that will not break, and requires more insulation. It is harder than copper, however, and hence in automobiles and especially airplanes it can be used for parts like the oil pan of the engine, where the strength of iron is not required and lightness is desirable.

Luckily, aluminum is contained in common clay and in a great number of rocks, so that the supply is practically unlimited. The chief drawback is that strong electric currents are required to extract it from the ores. Therefore the great aluminum plants are located where the ore occurs near powerful waterfalls such as those of Schaffhausen, Switzerland, and Niagara Falls. Savoy in France and the mountainous portions of Germany and Italy are also the seat of aluminum factories. If power could be obtained cheaply enough, aluminum would soon be used more than any metal except iron. The towns where it is made are likely to be located in pleasant parts of the country, for that is where the waterpower is found. They do not have a large body of low-grade laborers working underground, for the ore, known as bauxite, is taken from open quarries, requiring relatively little labor. Moreover, the amount of machinery and of skilled work required in the production of aluminum is unusually large. Altogether aluminum has a considerable number of favorable characteristics in its effect on men.

Why We Need to Conserve Our Mineral Deposits

Minerals far more than forests need to be carefully conserved. Forests can grow again, but when minerals have once been dissipated they can never be replaced. Among the metals discussed in this chapter gold and silver are conserved with great care, for everyone is careful not to lose the smallest bit of either. Yet they need to be conserved far less than the other metals, for they play little part in the world's work. Iron plays so great a part that our supplies of that metal are our most important metallic resource. As yet, however, they have not been seriously diminished, for



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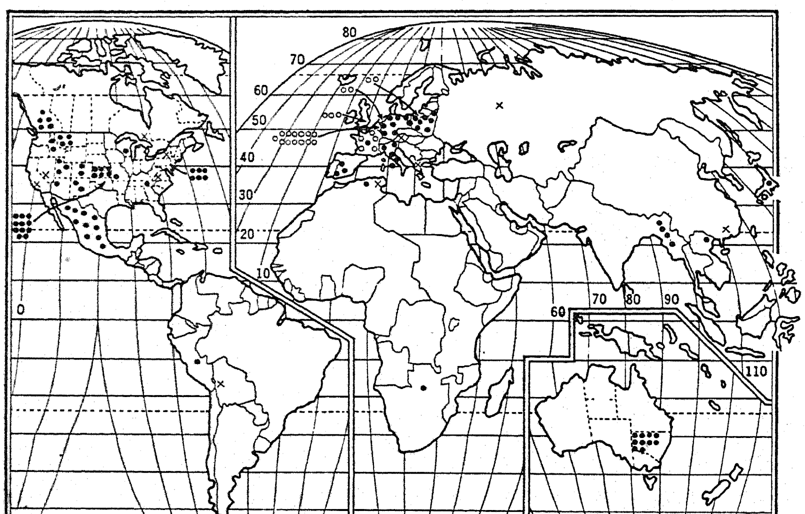
A—World Production of Lead.



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B—World Production of Zinc.

there are vast quantities of low-grade ores. Aluminum is fortunately far more abundant than iron, and the supplies have as yet scarcely been touched. With copper the situation is far more serious. Its use is constantly growing, while the supplies are rapidly being exhausted. The same is true of many minor minerals, such as zinc, lead, phosphates, and tin. If they are once exhausted many of our industries will suffer seriously, and future generations will wonder how we could have been so careless.

Metals and International Friction

Because of their scarcity and irregular distribution, metals are one of the great causes of international troubles. If there were no such thing as war, and if all nations were equally free to trade everywhere, there would be no trouble. Each nation could then buy metals wherever it chose at the same price and with the same freedom as every other nation. In actual practice there are all sorts of restrictions and limitations, and there is great fear that war will cut off supplies from other countries. The metals, as we have seen, are used mainly in the world's great manufacturing centers. The industrial sections of the United States, Great Britain, France, Germany, and Belgium use much more than half of practically all metals. The industrial parts of Russia, Japan, and some of the minor nations use most of the rest. No country has a supply of all the metals that it needs. The United States is better off by far than any other country. Nevertheless, we have to import such metals as nickel, tungsten, and manganese. Such metals are needed for many of the most useful kinds of machines such as automobiles. Varieties of steel which are especially tough, or hard, or have special electrical qualities can be made only by alloying iron with manganese, nickel, vanadium, or other metals.

Russia comes next to the United States in the variety and extent of its mineral resources. They are far inferior to those of this country, however. Moreover, they are not well located. Iron ore, for instance, has to be transported long distances by rail to reach deposits of coal. Many of the metals are found in small deposits in remote and almost inaccessible parts of Siberia. Nevertheless, the Soviet Republic, like the United States, can get along with only a little importation of minerals from other countries.

Great Britain has good supplies of coal and iron within its borders, but needs to import some iron ore and the great majority of other metals. It gets some iron ore from Spain and Sweden, but most of its needs for other metals are supplied by overseas dominions and colonies. Thus Great Britain is fairly safe, provided it retains control of the sea and its ships can travel freely. The other great powers, Germany, France, Japan, and Italy, are much worse off in respect to minerals, especially metals,

than are the United States, Soviet Russia, and the British Empire. Old Germany had plenty of coal and France plenty of iron. If they had been friends, their combination of coal and iron would have been admirable, for the German coal around Essen and in the Saar district lies not far from the French iron ore in the Minette district of Lorraine. Unfortunately, however, they have often been at war and are always jealous of each other. Germany's need of metals was one reason why she wanted to take Poland, reconquer Lorraine, and extend her power to the Balkans and Turkey during the second World War.

Italy's extreme poverty in practically all metals and fuels is one reason why that country hesitated so much as to which side she should support in both world wars. Although Japan has copper and coal, the coal is not sufficient, nor is it of the best quality. The desire to control the iron and coal of China, especially in the interior province of Shansi, was one of the dominant reasons for the long and bloody war with China. The geographical distribution of minerals is one of the greatest causes of international troubles and wars.

QUESTIONS, EXERCISES, AND PROBLEMS

1. How do you explain the lack of mining in Denmark? In Florida?
2. Why are swindles so easily made with mining stock?
3. Why is iron more precious than the "precious metals," gold, and silver?
4. What would be the probable effect on prices if no new gold mines were to be opened for several decades?
5. Why is the world's largest business combination one that deals with iron rather than any other material?
6. How far is the international position of the English-speaking countries strengthened by their control of the chief metals?
7. Point out which of the following are desirable in order to conserve our natural resources:

(*a*) The building of ships and bridges with reinforced concrete instead of wood or steel.

(*b*) The use of aluminum instead of copper in pots, kettles, and electrical machinery.

(*c*) The substitution of steel passenger and freight cars for those of wood.

(*d*) The use of aluminum in many parts of automobiles and airplanes in place of steel.

CHAPTER XV

SOURCES OF POWER

Importance of Power

In the present Age of Steel and Electricity all sources of power have assumed a new and increasing importance. The manufacturer needs power to drive his machinery, to bring raw materials, and to carry his finished products to market. The merchant needs power to run his elevator, and supply him with light. The farmer needs it to plow his fields, saw his wood, sharpen his scythes, churn his butter, and carry his crops to market. You yourself need power to light your home, to carry you on journeys, and to bring you letters and supplies. It is clear, therefore, that everyone in a civilized community uses power either directly or indirectly. Farms, transportation systems, and factories, however, are the greatest users of power. Hence in this chapter we shall think particularly of their needs in considering the seven great sources of power: (1) man's own body, (2) animals, (3) wind, (4) water, (5) wood, (6) coal, and (7) petroleum. atomic energy

a I Intro b c d e f g II

Man as a Source of Power

The oldest and most common source of power is the energy of *man's body*. He uses it to raise food, build houses, carry loads, and wield the ax. He also uses it for manufactures such as the woolen rugs of the Khirghiz and the carved toys of the Swiss.

In tropical countries man's strength is still a chief source of power. Even now, for instance in India, Africa, and tropical South America, long lines of coolies trudge hundreds of miles through jungle and swamp weighed down with heavy loads on their heads or backs. In China the wheelbarrow is often used to aid man's strength in carrying both goods and people; in Japan the jinrikisha and millions of bicycles serve the same purpose to better effect. In the most advanced countries, although millions of men furnish power for transportation, unlike the coolie they transport their loads only short distances, as in carrying bricks and mortar, loading boxes into wagons, and lifting leather into cutting machines. Even in Europe, however, the bicycle is still a major means of conveyance. Cities such as Copenhagen are so full of bicycle riders that the motorist

must often move slowly at their gait. In eastern Europe a villager or peasant who owns a bicycle is considered rich. In our own country, man's bodily power is used less than anywhere else. Its place is taken not only by motor vehicles, trains, and power boats, but by many other devices, such as elevators and electric trucks.

Animal Power

Since man's own strength is not sufficient to accomplish all his ambitious plans, he long ago obtained other sources of power by taming the ox, ass, horse, water buffalo, camel, llama, yak, elephant, and reindeer. His use of one or another of these animals, quite unlike his use of his

A—Spinning in Palestine. An example of primitive industry where human power alone is used.

own strength, is least in tropical countries and greatest in the most advanced parts of the world.

In tropical countries animals are little used for two chief reasons: (*a*) The people are not energetic and intelligent enough to take good care of their animals. (*b*) The most useful animals, such as the horse and

ox, do not thrive in tropical countries because of the poor grass, pestering insects, and warm moist climate. The fine animals introduced by the United States into the Philippines deteriorate rapidly even on well-run farms, and still more if left to the care of the natives.

In countries such as Japan and eastern China, horses and other beasts of burden are also rare. The summer climate is not favorable to their health. It also encourages the growth of very coarse kinds of grass which are not good for forage. Moreover, the places where food for animals might be raised are needed to supply food for the dense human population. In dry, grassy regions such as the steppes of Central Asia and our own western states, horses and cattle are numerous, for there is much land that is good for grazing and not for agriculture. Nevertheless, animals are not used for power nearly so much there as in the great agricultural regions of Western Europe, especially northern France and the Low Countries. In such places horses are so valuable for farm work that their number is increasing in spite of motor vehicles. Even in the United States 15 or 16 million horses and mules still work on the farms, especially in the southern states.

How Wind Furnishes Power

The sources of power thus far considered demand little mechanical skill, although the full use of horses was delayed two thousand years for lack of a good harness, horseshoes and four-wheeled wagons that could easily turn corners. The use of wind, however, demands that people shall be inventive and able to construct machinery. Many countries have passed through a windmill stage. The chief development of windmills has taken place in the energetic temperate zone. In level open regions such as Holland, Wisconsin, and Iowa, where the wind blows freely and steadily, most of the farms had such mills before the gasoline motor was invented. Many are still used to pump water into tanks, and to cut wood and fodder. In eastern Persia northerly gales which blow steadily for about four months in summer are still utilized to turn clumsy windmills with a vertical axis (A320). The mill is surrounded by a square mud wall which is open on the south side and half open on the north. The wind blows through this half-opening against fans that are like doors fastened solidly to the central axis. This whirls the axis around and thus turns a millstone fastened to its base. Within the tropics windmills were unknown until Europeans or Americans introduced them. The West Indies are full of the ruins of massive stone sugar mills run by the wind. Merida in Yucatan used to look like a regular forest of windmills. Most of its 65,000 people used water pumped by the wind from caverns and streams deep down in a porous limestone.

Aside from windmills, sails are the chief method of using the power of wind. In China wheelbarrows as well as ships are propelled in this way. Although windpower is cheap its use for ships has greatly declined, and the same is true of windmills. In 1800 all ocean vessels were propelled by the wind, for steamboats were still unknown. In 1870 the number of vessels of the two kinds in Great Britain was about equal. In 1922, the steam tonnage of British vessels of 100 tons or more was over 115 times as large as the sailing tonnage, and since then commercial sailing vessels have almost disappeared. They are so rare that their voyages

A—Vertical Windmills for Grinding Grain in Eastern Persia.

The mills can be run only when the violent north winds of summer, an extension of the trade winds, are blowing. A cover of snow, such as the one seen here, is rare.

from Australia to England with cargoes of wheat are featured in the newspapers. In the United States the steam tonnage is over 20 times as large as the other. We have a large proportion of sailing vessels because they are adapted to coastwise trade, which our laws encourage, while for transoceanic trade, which our laws have rarely encouraged, steam vessels are almost universally employed. Even in our own country, however, the use of sailing vessels is only half as great as it was in 1910.

One reason for the decline in the use of windpower is that the wind may die down just when it is most needed, whereas various types of engines have become more and more reliable. Another reason is that

only a few improvements in sails have been made since the days when ships were depicted on the old Egyptian monuments. If one of the readers of this book should invent a cheap storage battery, it might enable the power of favorable winds to be saved for times when there is no wind. Such an invention might go far toward solving the great problem of how the world shall continue to have cheap power when such fuels as coal and petroleum are exhausted or have risen to exorbitant prices.

Waterpower

This subject is considered in Chapter VI, on "Inland Waters," and should be reviewed at this point. See Pg. 271

Wood as a Source of Power

The sources of power thus far considered fall into two great types: (*a*) power derived from living beings, including both animals and man; and (*b*) that derived from the movement of air and water. We must now consider a third type, (*c*) power obtained by burning fuel. Fuel may be burned slowly as in a fire, or explosively as in a gasoline engine. The three chief forms of fuel are wood, coal, and petroleum. Let us see what special geographical conditions cause one to be used rather than the others.

Although wood was originally of great importance as a source of power, its use for that purpose has reached a low ebb in more advanced regions. In such regions transportation systems and farmers almost never use wood for power, and factories use it only for special reasons. Furniture factories have such a reason because they can use their own sawdust, shavings, and chips. So do the Swedish iron works at Dannemora, where iron ore is smelted with wood in the form of charcoal. This is partly because the surrounding forests furnish a vast supply of wood, but chiefly because certain of the finest grades of tool steel can be produced only with charcoal.

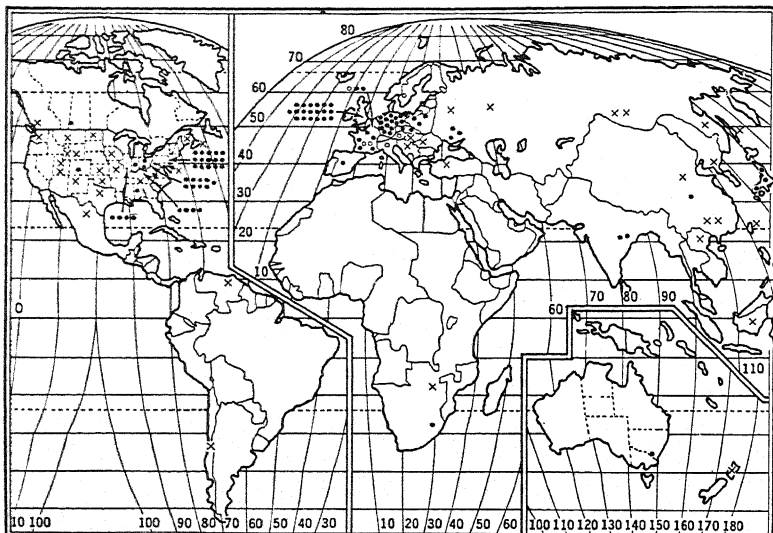
In backward regions, which comprise more than half the earth's habitable surface, wood is still the chief source of power. This is the case chiefly in heavily forested regions, or else in countries where the difficulties of transportation make coal unduly expensive. In the vast forested plains of northern Russia and Siberia, for example, the great piles of cordwood that one sees stacked up beside the railways are fed into the locomotives and produce a shower of sparks equal to a Fourth of July celebration. In tropical regions, too, the river steamers often stop for hours on the edge of the forest to let a crowd of half-naked black men throw sticks of firewood upon the deck.

In such backward regions the factories as well as the transportation

systems commonly use wood for fuel. Both in *number* and *size,* however, the factories that use wood are insignificant. For instance, in tropical countries the scattered little sugar mills, hemp factories, canning factories, and rubber-smoking plants are some of the kinds that depend upon wood or other vegetable fibers for fuel.

Coal as a Source of Power

If there were no coal, manufacturing could be carried on by means of wood and waterpower, but its development on a large scale would be impossible. Factories require so much fuel that on the present scale they



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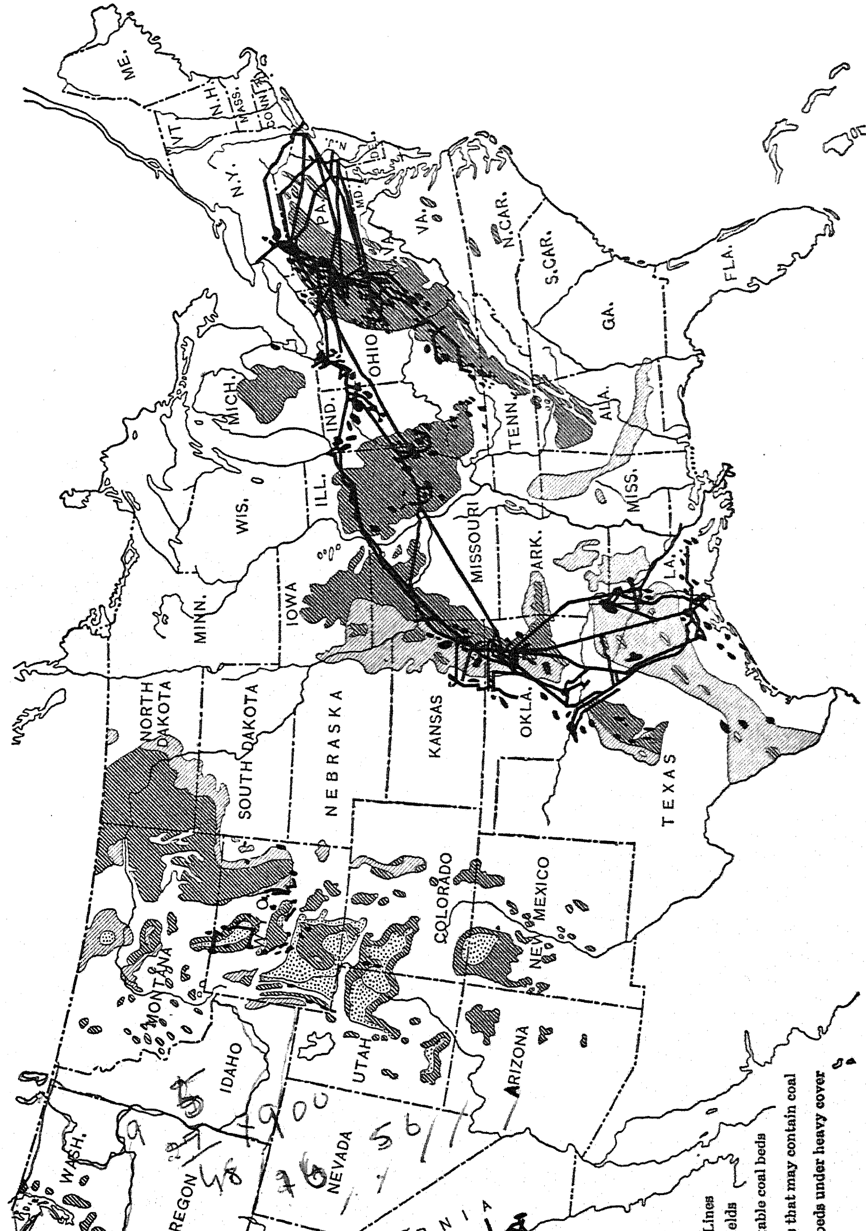
A—World Production of Coal. Solid dots, 1 per cent of world total. Crosses, minor amount. Open circles, import of 1 per cent.

would soon exhaust the world's wood supply. The United States mines about 500 million tons of coal each year. To get an equal supply of power from wood would require one and a half billion tons of cordwood, which would be three or four times as much as all the wood used each year in the United States for both fuel and lumber.

(1) *Progressive Countries with Much Coal.* The geographical distribution of coal is highly favorable to human progress. Large supplies happen to be located in places where the people are physically active and have alert, inventive minds. The countries of the world may be divided into four groups according to the activity of the people and the



A—Coalfields, Oilfields, and Oil Pipe Lines in the United States.

abundance of coal. The first group consists of progressive countries with much coal. It includes Europe from eastern Germany westward, and the northeastern quarter of the United States east of the Mississippi. Not every part of these regions has coal at its very doors, but all can bring it without difficulty and therefore share in its benefits. In England, more than elsewhere, great supplies of coal, as well as iron, in the midst of a large population gave the steam engine full opportunity to develop. In proportion to its size Great Britain has much the largest and best deposits of coal in the world. The United States, to be sure, has much more coal than Great Britain, and for household use Pennsylvania anthracite is better than even the finest Welsh coal, but this country is thirty-four times as large as Great Britain. The extent to which coal is mined in various countries appears from the fact that Britain normally produces about 6 tons per inhabitant, the United States 5, Belgium 3, and Germany 2 or more. In proportion to population these four countries are the greatest producers of coal. They are also the leading manufacturing countries.

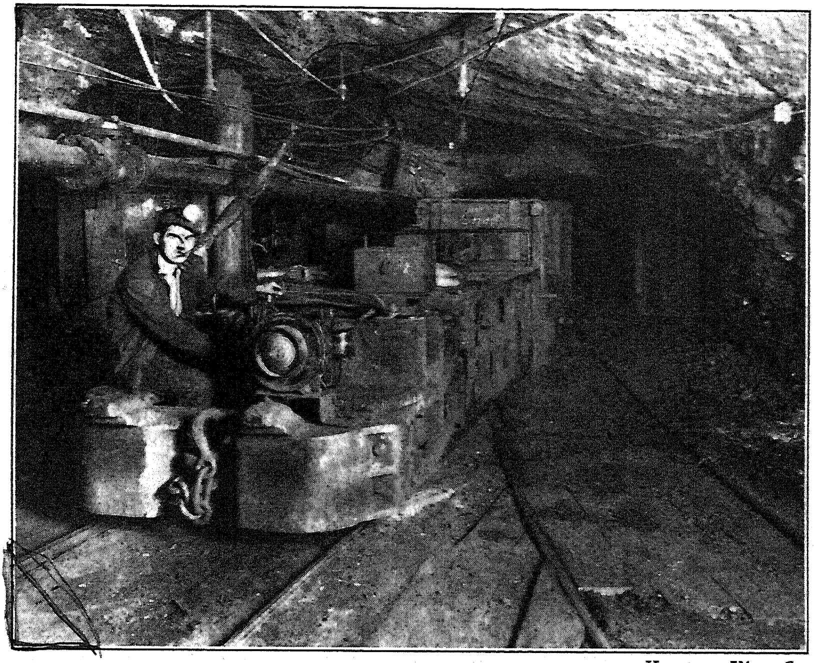
(2) *Progressive Countries with Small Coal Supplies.* Next in coal production to the countries just named come France, Canada, and Australia with about 1½ tons per inhabitant. Then follow South Africa, with 1 ton, and Russia and Japan with only half a ton. At least portions of each of these countries are inhabited by people so wide-awake and energetic that they have developed their coal to great advantage and are thereby able to carry on a good deal of manufacturing. Many other progressive countries, such as Italy, Sweden, and Argentina, have so little coal that it is negligible as a factor in their industries.

(3) *Backward Countries with Much Coal.* China and Indo-China have large deposits of coal, those of China being second only to those of the United States and Canada. Yet the coal has remained largely unused. Only under the recent influence of Europeans has it begun to be exploited. The lack of manufactures in these countries compared with the activity of manufacturing industries even in countries with limited supplies of coal, such as France, Switzerland, New Zealand, and Japan, shows that coal alone is of little importance in developing industries unless there are also energetic people.

(4) *Backward Countries with Little Coal.* Tropical countries are the least favored in their supplies of coal. Peru, Colombia, Venezuela, and Brazil, to be sure, have a little, but they have never mined it extensively. India, in proportion to its population, has no more than these countries, but the English have caused it to be developed. Other tropical countries appear to have almost no coal, although there may be large supplies as yet undiscovered. At any rate, coal has had little effect on their industries.

Conservation of Coal

Since coal is the most important mineral aside from iron it should be most carefully conserved. The world is using up its coal at the enormous rate of between 2 and 3 billion tons a year. If the use of coal should continue to increase at the present rate, all the coal now known to be minable would be gone in 150 years. Even if the rate of increase declines, as it seems now to do, and we cease to waste so much, the coal will be largely exhausted in not much over a thousand years. Then what will



Keystone View Co.

A—Hauling Coal in a Coal Mine.

our descendants do? No other known fuels can fill our needs. The world's supply of peat, for example, is estimated at 13 billion tons. This sounds large, but if peat had to be substituted for coal the entire supply would be gone in six or seven years. Oil is far more important than peat, but we shall see later how far it comes from taking the place of coal.

Fortunately much of the coal of the United States still belongs to the nation as a whole. Therefore it can be carefully guarded so that it may not be wasted or given away to favored individuals as has happened so largely in the past. Moreover, there are many ways of decreasing the waste of coal. (1) For example, in carrying coal from the mines to

the factories we use an enormous amount of power in running the trains. Experiments in England and the experience of power plants in America show that by burning the coal at the mines and sending the energy by electricity to factories, we could save the coal consumed by thousands of freight trains, and make our cities clean and wholesome. The same purpose would be accomplished, at least in part, by burning the coal at seaports, where it could be delivered inexpensively, and sending the power to the cities of the interior.

(2) When coal is burned in a steam engine an average of only about 15 per cent of the possible energy is converted into power. Unless the rest is used in some other way, the other 85 per cent is wasted in the heat that goes off into space. When the 15 per cent is used to produce light there is a further enormous waste, so that the final power used in ordinary electric lights is less than 1 per cent of the original energy of the coal. Already we have learned that gas and excellent gasoline can be extracted from coal and exploded in such a way that the loss of energy is much less than with the steam engine. Powdered coal also appears to supply much more power per ton than solid coal. Further inventions are possible which will prevent the enormous waste of power which now occurs when we use coal for heat and light.

(3) One of the greatest sources of waste in coal mines is the pillars and walls that are usually left to prevent the roof from caving in and killing the miners. Sometimes the coal thus left is recovered by "robbing" the pillars, that is, by digging them out after the rest of the work has been done, and letting the roof cave in. In a sparsely inhabited country this process is allowable, but it is dangerous where there are many houses on the land above the mines, as it is likely to wreck their foundations when the surface slowly sinks down. Around Scranton, for example, there are numerous big hollows where the ground has thus caved in. In the future, however, coal is likely to be so valuable that it may be worth while to substitute concrete pillars for those of coal, and thus save millions of tons which are now wasted.

The Life of Coal-mining Regions

Although coal is of tremendous value in manufacturing and transportation, it is in some ways a hindrance to civilization because of the life at the mines. The process of breaking out the coal and loading it into little cars far underground is monotonous and tiresome. The miners are not particularly well paid, for the work does not require much skill. Moreover, coal mining is one of the most unhealthful and dangerous occupations. The presence of coal dust and "fire damp" in coal mines impairs the miners' health by constantly obliging them to breathe polluted air.

Explosions caused by fire damp, dust, and the careless use of high explosives take many lives. The greatest danger, however, is the falling of pieces of the roof and wall which often bury the miners. Hence, even more than in most industries, those who are more competent seek work in other lines where there are better opportunities. Their places are usually taken by less competent workers, who, until the first World War, came to America in a steady stream from the more backward countries of the Old World. So many immigrants thus poured in that in many mining regions where they lived by themselves it was not possible to Americanize them. They still spoke their old languages, followed foreign customs, thought in foreign ways, and sometimes resorted to the kind of mob violence which is common where ignorant people, who feel themselves wronged, gather in idle crowds.

Under such circumstances, the conditions of homes, schools, and churches, and of social life in general cannot be the best. Strikes, too, are common. In the history of the United States the worst of all strikes have occurred in coal mines such as those of West Virginia, Kentucky, southern Illinois, and Colorado. Such strikes are most likely to occur in isolated communities inhabited largely by a foreign-born population. Since the miners are ignorant, both politics and social life have usually been dominated either by unscrupulous mine owners or labor agitators. Since other industries are not well developed, it is not easy for the miners to enter other occupations, and there is no body of skilled laborers, merchants, and other substantial people to act as a balance wheel. Hence when strikes occur, violence is woefully common on both sides. On several occasions serious fighting has taken place, and United States troops have been brought in because the local police and even the state troops have been unable to cope with the trouble. This oft-repeated condition has led the great coal State of Pennsylvania to establish an effective state police force, or "constabulary," which is used in preventing disorder when strikes occur.

In England, also, the coal mines have been the scenes of some of the worst strikes. During the first World War the miners saw their opportunity to demand higher wages. A temporary strike threw the country into great alarm, for if the coal supply had been cut off, the operations of both peace and war would have been brought to a standstill. Thus it appears that, while coal is one of the foundations of modern industry, the actual work of mining the coal is a hindrance to civilization.

Petroleum and Natural Gas

(1) *Why They Are Easily Obtained.* Although petroleum and natural gas have been known from early times, their common use for light and

heat did not begin until about 1860, nor for power until near the end of the century. Among the world's important fuels petroleum and natural gas are (1) the most easily obtained, (2) the most easily distributed, (3) the most varied in their uses, and (4) the most easily exhausted. They are easily obtained because, when holes are drilled in the deep-seated rocks where they accumulate, the pressure causes them to well up. Often oil and gas gush out so violently that the well-drilling tools fly high in the air, and the flow cannot be checked for days, or even months. Such "gushers" sometimes take fire. When oil was struck at the San Bocas well in the Tampico oilfield of Mexico in 1908 the oil that gushed out caught fire from the drilling engine. It burned 57 days, consuming 175,000 barrels of oil a day, and wasting material worth $3,000,000. The flame was 800 to 1,400 feet high and gave so much light that a newspaper could be read by it at night 17 miles away. Such a well, when properly capped, is worth thousands of dollars a day.

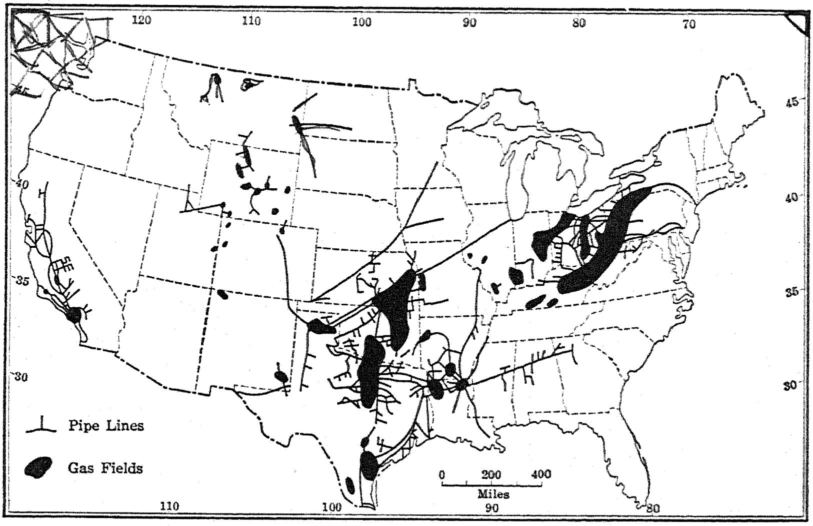
When such huge returns are possible from the insignificant labor of drilling a well, it is not surprising that the search for oil has been carried on with the same eagerness as that for gold. When new oil territory is opened, prospectors rush in to get hold of the best sites, and there is all the reckless excitement, quarreling, and trickery which occur during stampedes for gold. The first days of the California and Texas oilfields, for example, were marred by great lawlessness.

(2) *Why Petroleum Can Easily Be Transported.* Petroleum can be transported cheaply because it can be pumped into tank cars or tank steamers as easily as water. It can also be driven through pipes for hundreds of miles, thus giving it an extremely cheap mode of transportation. Pipe lines today run not only from the oilfields in Pennsylvania and Illinois to New York, but also from Oklahoma to Chicago. In Asiatic Russia a pipe line runs from the great Baku oilfield on the Caspian Sea to Batum on the Black Sea. Others carry oil from Irak to the Mediterranean.

(3) *The Use of Natural Gas.* The waste of natural gas has been far greater than that of petroleum. In Pennsylvania the gas which usually accompanies petroleum was long ago led into pipes and utilized for cooking, lighting, heating, and other purposes. It supplied the Pittsburgh region and other sections of Pennsylvania, West Virginia, and Ohio with very cheap fuel for many years. Almost every house used it. In more remote oilfields, however, the natural gas was mostly wasted until about 1925. The local market for it was so small that it did not seem worth while to bother with it. Then the owners of oilfields suddenly awoke to the fact that gas can be transported long distances by pipe lines even more cheaply than oil. At first it is carried along by the pressure of the

well behind it, and then its movement is aided by compressors. At once a great many pipe lines were constructed, and now they spread over the country as widely as pipe lines for oil (A329). St. Louis, Chicago, and Detroit use gas from Louisiana, Oklahoma, or Texas. No other commodity, except perhaps water, is transported so cheaply.

(4) *The Varied Uses of Petroleum.* By far the greatest uses of petroleum are for power and light. 4 Sometimes it is burned in its crude form. a For instance, in the southwestern United States and southeastern Russia oil-burning locomotives are used, not only because the railroads are near the oilfields of Oklahoma, Texas, California, or Baku, but also



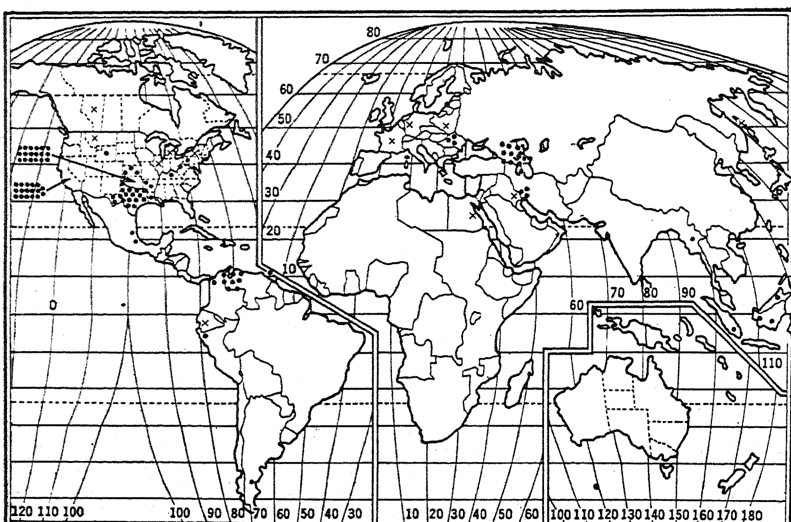
Courtesy of Economic Geography and J. K. Rose.

A—Natural Gas Fields and Pipe Lines in the United States.

because oil can be brought to the fire more easily than coal and saves cruel labor for the firemen. All modern warships and three-tenths of the merchant ships are oil burners. b This is not only because of the ease and speed with which this kind of fuel can be put aboard, 1) but also because smaller crews are required, and the otherwise wasted space between the 2) two parts of a ship's double bottom can be utilized as bunker space for oil. Since about 1920 there has been a rapid growth in the use of oil for heating houses. Much older than this is the use of kerosene for light. c City people often fail to realize the tremendous importance of this, but among farmers and in backward countries kerosene is the main illuminant. 1) Even in the United States kerosene is still the source of light on 7 farms out of every 10.

a) In its use for power, petroleum possesses a great advantage because it can not only be burned, but also exploded, thus giving power without the intervention of a boiler and steam. Everyone is familiar with this in automobiles, where the refined petroleum product known as gasoline is employed. A heavier and cheaper distillate, or even crude oil, is similarly exploded in the Diesel engine. More steamships are now equipped with this kind of engine than with steam engines.

5 As a lubricant the effect of petroleum upon the development of power has been about as important as its effect as a fuel. Modern methods of utilizing power demand high-pressure steam engines, and high-speed



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A—World Production of Petroleum. Each dot indicates 1 per cent of world production. Crosses indicate minor amounts.

machinery like dynamos, motors, automobile and airplane engines, and many machines in factories. Such machinery must be lubricated with a high-grade oils. Petroleum supplies the only oils that are cheap, abundant, and able to stand the high temperatures of high-pressure steam engines. Without petroleum or its substitutes made from coal our present vast use of power would be almost impossible.

(5) *Why Petroleum Should Be Used Sparingly*. By its very nature petroleum tends to rapid exhaustion. At first, when a source of oil is tapped, the gushers often waste a great deal; later they merely flow gently; next they cease to flow naturally, and must be pumped; and finally the wells that are pumped give a smaller and smaller output. A well that lasts

a generation is rare. In spite of the drilling of new wells, the yield of the Pennsylvania field fell from 33 million barrels in 1891 to only 7 million in 1921, but it has again gone up to about 10 million. Pennsylvania ranked as the world's greatest producer in 1890 but forty years later it had been surpassed not only by foreign fields such as those of Tampico, Baku, and Venezuela, but also by Oklahoma, California, Texas, Louisiana, Kansas, Arkansas, and Wyoming, as well as by Illinois, which in that period became a great producer and then fell to relatively low rank. The way in which production changes is well illustrated in the following table.

PETROLEUM PRODUCTION, MILLIONS OF BARRELS

	1900	1909	1913	1921	1932	1939	Percentage of World Production, *1939
United States	63.0	182.0	248.4	472.2	781.8	1249.0	60.5
Russia	75.0	65.0	60.9	29.2	155.3	222.0	10.7
Venezuela	.....	.....	.....	.....	116.3	210.0	10.2
Iran	.....	.....	.....	16.7	49.5	77.0	3.7
Dutch East Indies	2.2	11.4	11.9	17.0	39.0	67.0	3.2
Rumania	1.6	9.3	13.5	8.4	54.2	47.0	2.3
Mexico	.....	.....	25.6	193.4	32.8	42.0	2.0
Iraq, Bahrein	.....	.....	.....	.....	.....	41.0	1.9
Colombia	.....	.....	.....	.....	16.4	23.0	1.1
Trinidad	.....	.....	.....	2.4	10.1	19.0	0.9
Argentina	.....	.....	.....	.....	13.0	18.0	0.9
Peru	.....	.....	.....	3.7	9.9	13.0	0.6
India	1.0	6.6	7.5	8.7	8.4	10.0	0.5
British Borneo	.....	.....	.....	.....	2.4	7.0	0.3
Germany	.....	.....	.....	.....	1.6	4.0	0.2
Sakhalin, Russian	.....	.....	.....	.....	2.8	3.9	0.2
Poland (old area)	5.7	14.9	?	5.2	4.1	3.8	0.2
Japan	0.8	1.8	1.0	2.2	1.6	2.6	0.1
Ecuador	.....	.....	.....	.....	1.6	2.2	0.1
Egypt	.....	.....	.....	.....	1.8	1.6	0.1

* Smaller producers, 1938.

The demand for petroleum, especially for automobiles and for lubricants, is increasing enormously. If the present conditions continue, there is no knowing when the supply will be exhausted. A decade or two ago the geologists feared that the supply would be almost used up by now, but at present the reserves of oil in the rocks are supposed to be far more extensive than was formerly estimated. Moreover, vast beds of shale in Colorado, Scotland, Estonia, and other regions yield oil when heated. The process is costly, however, and Scotland is the only country where there has thus far been large production. The oil shales will probably be avail-

able long after the liquid petroleum is largely exhausted. Coal also yields petroleum when heated. The supplies available from this source are large, but gasoline produced in this way costs about four times as much as when distilled from petroleum. If we look far ahead, it is clear that future generations will think us barbarians and fools unless we use our oil very carefully and without waste.

How Petroleum Influences Human Activity

In its effect on man, the geographical distribution of petroleum is much less important than the distribution of coal. If its value for fuel had been known earlier it might have caused manufacturing cities to grow up where it occurs, but now this rarely happens. This is partly because petroleum is so easily transported, and partly because towns in oil-producing regions are generally disagreeable. Even the better residential portions usually smell of oil, while the parts where most of the people must work are very dirty and greasy. Slimy, oil-covered pools are scattered among black, forbidding derricks. Another reason why manufacturing centers do not grow up around oil wells is that such places are rarely permanent. Like "boom" mining towns, they usually grow for a few decades and then decay as the oil gives out. There are exceptions to all this, however. The presence of oil has led to a rapid and apparently permanent growth of manufacturing and population in Los Angeles. Nevertheless, the suburban parts of that city are still among the most delightful of residential regions.

The most important effect of petroleum upon man is the way in which it has aided two great improvements in machinery: (1) It has made all sources of power much more effective by cheap lubricants for high-speed machinery and high-pressure steam engines. (2) It has led to the invention of the light engines which are necessary for the automobile and especially the airplane. If there had been no such thing as cheap, easily combustible fuel oils it is doubtful whether we should have had these means of transportation. When the world's petroleum and natural gas are practically exhausted and their places taken by alcohol and other substances still to be invented, further generations will still remember petroleum as a factor in one of the most important advances in transportation.

The Political Effect of Petroleum. The high value and limited distribution of petroleum make all the great nations eager to secure new supplies. This is especially true of countries such as England and Germany, which have little or none within their own territories. Even if countries have an abundance at home, however, their business men are eager to find new supplies, for the development of new fields is often

extremely profitable. Hence when a wonderfully productive oil region was discovered on the northeast coast of Mexico near Tampico, Americans, British, Germans, Dutch, and other foreigners all hastened to get control of as much land as possible. The production of oil increased so rapidly that, although it was negligible in 1910, Mexico soon stood next to the United States as an oil producer, and the Tampico region produced more oil than any other area of equal extent. Similar occurrences have taken place in Colombia, Iran, and especially Venezuela. In 1920 Venezuela produced practically no oil. In 1939 it rivaled Russia for second place and produced five times as much as Mexico. Political conditions there are so uncertain that the oil companies, chiefly American, British, and Dutch, immediately ship the oil away from Lake Maracaibo, where most of it is produced. It goes largely to great refineries on the neighboring islands of Oruba and Curaçao. Since these are Dutch, they were politically safe until the second World War.

The oilfields of Mexico have played a conspicuous part in international politics. Since Mexico has little coal, oil is by far her greatest fuel. It is used not only for factories, streetcar lines, and lighting systems, but also for about half the railways. Still more important from the Mexican standpoint is the fact that taxes on oil lands and on exported oil are an important source of government revenue. Because of these facts there was for a while much conflict among three sets of people, each wishing to get as much as possible from the oilfields: (1) the foreign exploiters who had acquired title to the lands and had invested much money; (2) the Mexican government, which felt that it must impose heavy taxes in order that Mexico might get its fair share of the great wealth that keeps flowing out of the ground; and (3) Mexican bandits and rebels, who also wanted a share in this wealth and sometimes terrorized the workers at the oilfields, robbed and even killed the paymasters and others, and thus compelled the oil companies to pay large sums for protection. The Mexican government was sometimes unable to prevent this or to punish the offenders. Such complications led many persons to say that people from the United States have no right to exploit the resources of their more backward and less competent neighbor, while others said that this country ought to intervene and give Mexico a good government.

In the end the Mexican government took the oilfields entirely away from foreign owners. It promised to pay for them. Inasmuch as Mexico, like most Latin American countries within the tropics, frequently defaults on its government bonds, this was not at all satisfactory, and much political argument ensued. To make matters worse Mexico agreed to sell a large part of the oil to Germany, thus adding a new complication. Then the second World War broke out, and England and France prevented any

oil from reaching Germany. Thus oil made the Mexican oilfield a political storm center for many years.

In certain respects the relation of Japan to the coal mines of China is like that of the United States to the oil of Mexico. A progressive country needs fuel which a less progressive country has in abundance, but is not using and has not known how to develop without outside aid. Japan elected to get Chinese coal by means of war. Thus the fact that a backward country contains rich supplies of a valuable source of power gives rise to one of the most difficult of political problems.

The Great Users of Mineral Wealth

The way in which pipe lines for both gas and oil run toward the northeastern manufacturing section of the United States, or else toward seaports from which it is easy to ship oil to that section, or to the similar section of Europe, illustrates one of the most important principles in the geography of minerals. This principle is that, no matter in what part of the earth a mineral occurs, there is a tendency for the most advanced parts of the world to get more than their share of the use of it. To put the matter in another way, the chief users of metals and fuels are the most progressive nations, especially those parts of them that are highly industrialized. A region such as Scotland, Germany, Switzerland, New York State, or California gets the minerals that it needs no matter whether it produces them itself or has to seek them far away. Thus there is a constant flow of both metals and fuels from regions of relatively little development to those of highest development. The more unusual a mineral is, the greater is the tendency. Such metals as vanadium, rubium, and tungsten, for example, are useless except in a few small regions where special kinds of steel are made or highly complex chemical processes are carried out. Therefore, wherever these materials may be produced, they are sure to be shipped to those few areas for final use.

This same principle is true even in application to such common commodities as iron and coal. Iron ores are normally brought to coal mines, but this happens mainly when coal mines are located close to one of the active industrial regions such as Great Britain, Germany, or the part of the United States from Buffalo to Chicago. The world's largest and best coal deposits happen to be located in these regions, and naturally considerable coal is shipped away from them. The significant fact about this, however, is that most of the coal goes either to other parts of the industrial sections, such as New York, New England, Minnesota, our Pacific Coast, France, and Italy, or to places where it will be used in ships or factories which are financed and managed by people from the industrial sections. The

production of minerals tends more and more to be spread all over the world. As new discoveries are made, there is a strong tendency to concentrate on the best supplies, no matter where they may be located. These are the ones that can be worked most profitably. Poorer deposits are worked mainly when there is a shortage, or when prices are high for some other reason. At the same time, the *use* of minerals tends to increase more rapidly in the industrial sections than anywhere else. Hence as time goes on those sections, together with the outlying businesses which they run, tend to use an ever-increasing percentage of the mineral wealth of the world as a whole. Chicago, Detroit, New York, Boston, London, Brussels, Essen, and Berlin use vastly more coal, oil, iron, and copper in proportion to their population than do Havana, Rio de Janeiro, Cairo, Bombay, and Canton. They use a still greater proportion of the rarer minerals such an antimony, bismuth, ruthenium, and columbium.

How Power May Be Obtained in the Future

In spite of all possible economies and inventions the time will surely come when new sources of power will be needed. Man power and animal power have long been insufficient. The space available for raising wood decreases as the world's population becomes more dense. Coal and petroleum are rapidly being exhausted. Among the sources of power now used only the wind and running water can be counted on as permanent sources of abundant power. It is estimated that when proper dams and reservoirs are built the streams of the United States may possibly supply more than 100 million horsepower. At present our factories and transportation systems use more than 30 million horsepower; the heat used in houses, and the power used on farms, in automobiles, and for all manner of minor purposes probably brings the total up to 50 million. Thus if the waterpower could all be utilized it would suffice for the present, but our population is still growing, and the amount of power needed per individual is increasing by leaps and bounds. Hence if we have 175 million people in 1970, we shall probably need much more than 100 million horsepower for all purposes including heat and light. Similar conditions will probably prevail in other countries. It is impossible to predict what may happen if densely populated but backward countries such as China and India begin to use power on a really large scale. It seems probable, however, that, even when all the waterpower has been harnessed, the world will ultimately need much additional power to heat houses, cook food, carry on industries, and keep transportation systems in operation.

Part of this can perhaps be obtained from the wind, but the greatest

source of power is the sun. In the drier part of Texas, where the sky is usually cloudless, any two average counties among the 245 in the state receive from the sun enough power to run all the factories and transportation systems in the entire United States. If we can devise means of using sun power directly and cheaply, one of the world's greatest problems will be solved. Today steam can be made in solar steam engines whose boilers are heated by concentrating the sun's rays by means of mirrors. Such engines, however, are too expensive to be practical, and can be used only in places where the sun is rarely clouded. The engineer who invents a solar engine that is practical and cheap, and that has sufficient storage to carry it through cloudy days, will do mankind a most wonderful service. When that is accomplished, we may hope at last to get rid of our strike-breeding coal mines except as places from which material for dyes, medicines, and so forth is extracted. We may also get rid of the factory chimneys that pollute the air of our cities. Perhaps our factory towns will be as clean and wholesome as those in Switzerland and other places that now use hydroelectric power. We may be able to extract aluminum cheaply and in enormous quantities and thus conserve less abundant metals such as copper, lead, and tin. We may perhaps pump water for irrigation so cheaply as to cultivate many dry regions that now are almost uninhabited. We may be able to heat our houses electrically with as much ease as we now light them. Think of the work and dirt that would be saved in that one way! The cost of transportation and of manufactured goods would be lessened, for now one of the largest items, especially in transportation, is the cost of coal. In short, if solar energy, or perhaps atomic energy, should ever become cheaply and easily available, life might be revolutionized almost as much as it has been by the invention of the steam engine; in most respects the change would be beneficial.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Make a list of ten industrial plants near your home, including at least one power plant. Classify them according to (1) the source of power; (2) the use to which the power is put; (3) the distance and method by which the power is transmitted; (4) the relative cost of the power and the reasons for choosing each particular kind.

2. In Switzerland tourists are surprised to see even the most primitive cottages lighted by electricity. List six other parts of the world where a similar development is likely to take place or has taken place. Arrange these in the order in which you think an investment in waterpower would be profitable, and give your reasons.

3. On a map of your home district, show the method of transportation by some such scheme as the following: railroads, a solid line, with little vertical bars across it; four-lane roads, a double solid line; other hard roads, a single solid line; trolley or bus lines, a double broken line; other roads, a line of dashes. Color the lines accord-

ing to the kind of power employed. Compare the routes according to (1) topography; (2) their value to the community; (3) the difficulties of construction.

4. Express the production of petroleum, coal, iron, or other minerals in various countries in the form of a graph.

5. Make a map of the world showing by different shadings or colors the kinds of power that are most common. Explain your map in terms of geographical environment.

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PART VII

MAN'S RELATION TO CLIMATE

CHAPTER XVI

CLIMATE AND LIFE

How Climate Affects Man Directly

The geographical distribution of health and energy depends on climate and weather more than on any other single factor. The well-known contrast between the energetic people of the most progressive parts of the temperate zone and the inert inhabitants of the tropics and even of intermediate regions, such as Persia, is largely due to climate. This arises not only from the direct effect of the weather upon human activity, but also from the effect of climate upon agriculture, diet, disease, occupations, and general progress. The indirect effects are often more important than the direct effects. In this chapter, however, we shall consider mainly the direct effects.

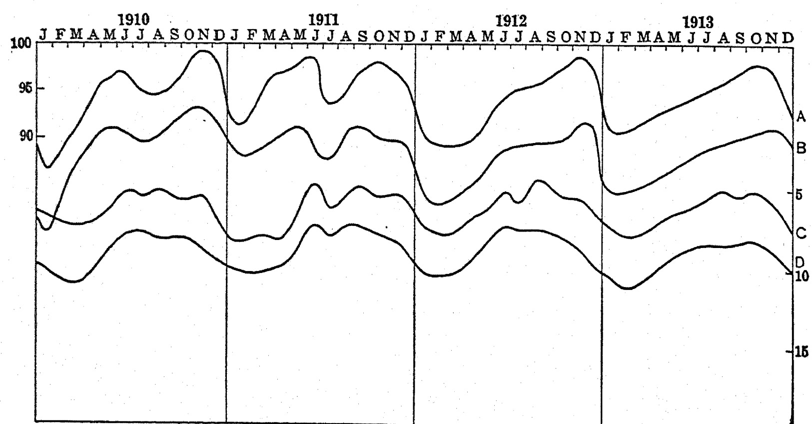
The best way to understand the direct effect of climate and weather upon health and energy is to consider how the weather causes our own condition to vary from day to day and season to season. Although some people are more affected than others, everyone is influenced by temperature, humidity, wind, sunshine, barometric pressure, and perhaps other factors such as atmospheric electricity and the chemical composition of the air. On days when all these factors are favorable, people feel strong and hopeful; their bodies are capable of unusual exertion, and their minds are alert and accurate. If all the factors are unfavorable, people feel inefficient and dull; their physical weaknesses are exaggerated; it is hard to concentrate the mind; the day's work drags slowly; and people go to bed at night with a tired feeling of not having accomplished much. Hence in variable climates like that of the United States, people's physical and mental energy keeps changing from day to day and season to season. Sometimes one feels almost as inert as if he lived within the tropics, but soon a change comes and one again feels the health and energy which make it possible to work hard and think clearly. Changes in people's energy can be detected by measuring how much they accomplish in a given time when the same kind of work is done day after day, as among piece workers in factories.

How Health and Energy Are Measured

There are many other practical ways of measuring variations in the health and energy of a community from season to season. They can be measured by means of the testing apparatus used in gymnasiums. The health of children can be measured by recording their rate of growth in height and weight. The health of the whole community can be measured by the number of deaths from disease, but in doing this, of course, we are dealing with indirect as well as direct effects of the weather. Or again the health and energy of the mind can be measured by finding out the difference from week to week in the work done by school children, bank clerks, or other people whose occupations demand brain work. Another excellent method consists of experiments where people are subjected to definite kinds of atmospheric conditions in artificially controlled rooms. Changes in blood pressure, rate of breathing, pulse rate, and chemical composition of the blood and other secretions all lead to the conclusion that, in a variable climate, such as that of the United States, people's health and energy go through a regular series of changes from season to season and day to day.

The Effect of the Seasons

How Physical Energy Varies from Season to Season. The variations in people's strength from month to month are so important and teach so much about the distribution of health and energy throughout the world that we may well study them closely. A340 shows how both work and



A—Seasonal Variations in Health and Efficiency. Amount of piece-work in factories of Connecticut (A) and Pittsburgh (B). Deathrates (inverted) in Connecticut (C) and Pennsylvania (D).

health vary in the northeastern United States from season to season. The upper curve is based on piece-workers in Connecticut factories, who were encouraged to work fast by bonuses. Curve B is of the same sort, but from Pittsburgh. Notice how the two go up and down together. They are low every winter, but rise steadily till May or June. In the first two years they drop somewhat in summer. Those two summers were very hot, especially the second. The third summer, however, was cool, and the fourth even more so. Accordingly there was no drop in energy, and the factory workers kept on doing better and better work until October or even the beginning of November. Even in the first two years when the summers were unfavorable the peaks in the curves during the autumn indicate excellent work. In the second year the autumn peak does not quite reach the level of the June peak, apparently because the excessively hot summer sapped people's energy so much that they did not fully recover even in the fall. Similar studies in Japanese factories show a similar prolonged effect of unduly hot weather.

The two lower curves show that health in Connecticut and Pennsylvania follows almost the same course as work, except that it lags somewhat. Health is measured in these curves by turning the curve of the deathrate upside down to agree with the curve of work. High parts mean few deaths and good health. Deaths, of course, lag behind the conditions of infection, diet, or weather that cause them. Thus in the first year curves *C* and *D* reach their lowest point later than *A* and *B*. This means that in January, which was very cold that year, people's efficiency fell off badly all over the northeastern United States. The same conditions which caused their efficiency to fall off diminished their vitality so much that many contracted diseases. Hence poor health and a great many deaths continued through February and March. The extraordinary thing about A340 is that year after year the four curves all fluctuate closely in harmony. No known condition except the weather could cause this.

The Optimum Season. The curves of A340 mean that the optimum or most favorable time for work in the northeastern United States is October. At that time people feel like working hard; they get up in the morning full of energy, and go at their work quickly and without hesitation; they walk briskly to business or work; and they play with equal vigor. Among healthy young workers headaches, colds, indigestion, and other minor illnesses are fewer than at other seasons, although among weaker and older people these begin to increase a little as soon as the weather becomes cool. Nevertheless until the nights become frosty there are relatively few serious illnesses, so that the number of deaths is almost as low as at the end of a cool summer when vacations, outdoor life, and fresh vegetables and fruit all help to preserve good health.

Then, as cold weather comes on, the workers accomplish less, ill health becomes more and more common, the physicians are kept busy, and deaths increase. By January or February the general efficiency may have dropped 10 per cent and deaths may have increased by 20 or 30 per cent. In a cold winter these bad conditions may last through March, but ordinarily there is an improvement as soon as the air begins to become warmer. The improvement continues through the spring, and in May or early June the conditions of health and energy are almost as good as in October. What happens after May depends on whether the summer is hot or cool. Very hot summers may cause people's health and energy to be little better in July than in January. The diseases are not the same in summer as in winter. Digestive troubles, for instance, are especially common in summer, whereas colds and other respiratory illnesses prevail in winter. Moreover, the feeling of laziness that comes over people in hot weather is not quite the same as the dull, tired feeling that one has in winter. Yet the effect on work and health and the result in low efficiency and many deaths are similar. In the northeastern United States, however, such debilitating summers are rare. More often the summers are the best time for health, so that they help to make the autumn the time when well people accomplish the most.

How the Effect of the Seasons Varies with Latitude. If we study the people of different latitudes we find that the periods of greatest and least energy occur at different times. In northern Maine or Minnesota, and still more in Canada, there is only one unfavorable period, the winter. People are at their best from July to September. Then health and efficiency decline steadily as the cold winter comes on, and in January and February reach a level below that which prevails during the same months in New York, Chicago, or St. Louis, for example. Farther south there are four periods, two of good health in spring and fall, and two of relatively poor health in summer and winter, but the contrast between the good and the poor is not so great as in latitudes a little higher or lower. In still lower latitudes there are once more only two periods, but in such warm regions the long summer is the unfavorable time, and the short winter is favorable. In central Florida, for example, the long warm summer shows a pronounced decline in health and rate of work lasting about six months, and the short winter is much the best part of the year. The loss of health and strength due to continued warm weather becomes more pronounced the farther one goes toward the equator.

In the other continents similar conditions prevail. In Europe, in the latitude of central France and southern Germany, the seasonal variations of health and strength are much the same as in Boston, New York, Cleveland, and Detroit. That is, people are most healthy and active in

October and early November and again in May and early June. They are weakest and most subject to disease in January, February, and early March; in hot summers there may be a mild decline in health and activity, although in other years this is often the best season. In Europe, as in America, great variations occur from year to year, according to whether the weather is unusually hot or cold, rainy or dry, variable or monotonous. Farther north, for example, in Scotland, Scandinavia, and Finland, the summer is almost invariably the best time of the whole year and the winter the worst. To the south, on the contrary, in Italy, Spain, and Greece, the harmful effect of the winter decreases and that of summer increases, until finally on the south side of the Mediterranean the winter is much the best time of the whole year, whereas the long summer greatly diminishes people's efficiency and increases disease and deaths.

How the Seasons of Mental and Physical Activity Differ. In general, people's mental activity varies from season to season in the same way as physical activity. Nevertheless, the marks of students, the percentage of failures in civil-service examinations, and the number of applications for patents unite with other evidence in showing an interesting difference in one respect. In the latitude of New York, for example, people do the best brain work in March and April, a month or two before physical strength reaches its spring maximum. In the fall, on the other hand, a period of unusually good brain work comes in late November or early December, a month or so after the best autumn season for physical work. This suggests that people's minds are most stimulated in weather somewhat cooler than that which most stimulates their bodies.

The Major Climatic Optima

(1) *Temperature.* Three conditions of climate are of special importance in their influence on health and energy: (1) temperature; (2) humidity; and (3) variability. For each of these there is a certain most favorable or ideal condition which is called the *optimum*. Every species of plant and animal has an optimum temperature at which it thrives most vigorously, and man is no exception. The optimum may vary a little from individual to individual, but not much. It is more likely to vary from one type of activity to another. People who play bridge or keep accounts in banks need a higher temperature than football players or lumbermen. The optimum varies, too, according to age, being high for newborn infants, low for children at the age of ten or so, and high again for old people. And finally it varies according to people's occupations, habits, and mode of life. Nevertheless, taking the white race as a whole, the best temperature is an average of not far from

64° F. for day and night together. Averages as low as 60°, however, or as high as 70° are almost equally favorable, provided there are no very hot days. Put in another way this means that people's health and strength are greatest when the thermometer drops to 55° or 60° at night, and rises to 70° or 75° by day. For mental work, however, the optimum appears to occur when the temperature outdoors—not indoors—averages a good deal lower than for physical activity, probably about 40° or 45°. As a rule, people do their best thinking and planning, their minds are most alert and inventive, and they have the best judgment during the part of the year when the thermometer out of doors falls toward freezing at night and rises toward 50° or 55° by day.

All human progress depends on activity of both mind and body. An active engineer, for example, is needed to plan a system of water works; active day laborers are needed to dig ditches. Hence the best climates appear to be those with an average temperature somewhat below 40° during the coldest winter month and somewhat below 70° during the hottest month. This gives the longest possible periods averaging about 45° at one season and about 65° at the other, thus providing the best conditions for both mind and body.

From the standpoint of temperature alone, regardless of other conditions, the region within about 400 miles of the southern part of the North Sea seems to be about the best part of the world. A circle drawn through Glasgow, Dublin, Paris, Berlin, and Copenhagen includes much of the best area. Other minor areas of similar temperature are found around Puget Sound and in New Zealand. Other factors as well as temperature, however, must be taken into account, as we shall now see.

(2) *Humidity*. The amount of moisture in the air is one of the important factors in regulating health and energy. We can measure this either in absolute units—so many grains of water vapor for each cubic foot of space—or in relative units—such and such a percentage of the total amount of vapor that the air will hold at any given temperature. The latter, that is, *relative humidity*, appears to be more important than the absolute humidity. At high temperatures almost everyone is conscious that humid air is uncomfortable. With the thermometer at 90° one can be quite comfortable if the humidity is 30 per cent, let us say, especially if a breeze is blowing so that dry air is constantly brought in contact with the skin. With a relative humidity of 80 per cent, on the contrary, and a similar temperature, one perspires at the slightest exertion. If such weather continues long, people feel weak and exhausted. In Japan the hot summer is so humid that everyone feels wilted. People become so weakened that in September the deathrate is higher than at any other season.

Extreme dryness at high temperatures is also undesirable. Studies in hospitals, for example, show a high deathrate not only after surgical operations performed in hot, humid weather, but also after those performed in hot weather that is especially dry. The lowest deathrate in hot weather comes when the operations are performed on days with a moderate degree of humidity. Again, the general deathrate for people as a whole is exceptionally high in hot dry cities, such as Seville in Spain and Allahabad in India. Cairo in the Saharan oasis of Egypt has one of the world's highest deathrates.

When the outdoor temperature averages below the optimum, that is, below about 65°, the best condition for health and energy appears to be a relative humidity high enough so that the air is almost saturated with vapor at night and dew falls abundantly. On a clear day of this kind the relative humidity may fall to perhaps 50 per cent at noon, but when cloudy and rainy days are included, the best average for health rises above 80 per cent for day and night together. The evidence for this lies in the fact that, when the temperature averages below the optimum, the deathrate rises higher in dry weather than in relatively humid weather with a similar temperature. In many countries the highest deathrate of all occurs in cold dry weather when there is no snow on the ground.

Just how much of all this is due directly to atmospheric humidity and how much to other conditions which accompany humidity is not yet clear. There is reason, however, to believe that although the humidity itself is important for man, just as it certainly is for plants, other conditions also play a part. One of these is the fact that humid weather in middle latitudes is also likely to be weather with a good many cyclonic storms and with fairly frequent changes from clouds and rain to fair, sunny weather. Another is that in dry weather the air tends to become dusty, and this is always bad for health. The dust is washed out of the air by the rain which falls during periods of high humidity. In cities such as Cairo extreme dryness causes the air to be dusty much of the time. The dust usually consists largely of tiny quartz particles which are very bad for the lungs. Moreover, in regions where there is a dry season of considerable length sanitation is often sadly neglected, sewage is not properly disposed of, and the streets and alleys are often filled with filth, which quickly becomes dry and powdery. The wind blows this far and wide, carrying with it many kinds of harmful bacteria.

What has just been said about unfavorable conditions in dry regions seems at first to disagree with popular opinion about the advantages of such regions for health. There is no real disagreement, however. Part of the disadvantages of dry regions disappear when people pay proper attention to sanitation and make sure that the air is free from dust. The others

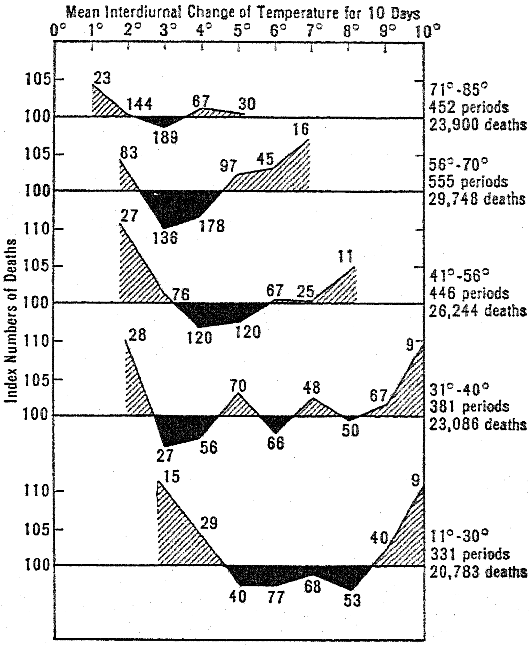
are neutralized in part by the fact that in dry regions people live a much more outdoor life than in those where rain falls every few days. If the people in the more humid regions would live out of doors as much as those in the dry regions, their climatic advantages would be much more apparent.

(3) *Cyclonic Storms and Variability.* The best climate for human activity must have the right conditions not only of temperature and humidity, including rainfall, but of some other quality which is intimately connected with variability from day to day. One of the most curious facts about climate is that in the United States, at least, a drop in temperature from one day to the next is systematically associated with a drop in the deathrate. A similar rise in temperature, on the contrary, is associated with an immediate rise in the deathrate. These two contrasted relationships prevail at all seasons. It is easy to see the reason for them in summer. At that season increasing warmth takes the temperature farther and farther above the optimum, whereas a drop brings it back toward the optimum. In winter, however, the opposite is true. Continued cold weather in winter is practically always associated with a high deathrate and therefore with lowered efficiency. A warm winter is associated with a low deathrate and high efficiency. Nevertheless, the *immediate* effect of a drop in temperature is so stimulating that the deathrate regularly drops decidedly on the day when the temperature drops and tends to remain low on the succeeding day. Then, if cold weather continues, the deaths increase. In the same way, on the day when the temperature rises and on the next day the deathrate also rises, but if the weather remains warm, the deaths diminish to a level appropriate to the temperature.

These strange and seemingly contradictory conditions evidently mean that the arrival of tropical and polar air masses has an effect on the human body different from what would be expected on the basis of temperature alone. The tropical masses, both in summer and winter, bring conditions which depress human vitality. The polar masses, on the contrary, at first bring the opposite conditions, thus stimulating people and preventing death. In each case the effect is short-lived, lasting only a day or two. Nevertheless, it is of high importance, as we repeatedly see in our own experience.

Take a week in April as an example. On the first day (1) there is frost in the morning, but a warm sun in a bright blue sky raises the temperature above 50° at noon, and people talk about planting their gardens. That night there is no hint of frost, even in the coldest hollows. The next day (2) a tropical front arrives, a warm moist wind blows from a southerly quarter, and the temperature approaches 70° at noon. The robins chirp on the lawn, the lilac buds swell visibly, and people wish

they were wearing summer clothes. This is all very pleasant, but it does not make people feel active. On the contrary it gives them "spring fever." They want to knock off work and bask in the sun, or do almost anything except stick to their work. The next day (3) clouds gather toward night. On the fourth morning (4) rain is falling, but in the afternoon the wind shifts to the west, the temperature falls rapidly, and in a few hours the rain comes to an end. That day people work steadily without thinking much about anything else. Late at night the clouds disappear, and the stars shine like twinkling points in a sky of crystal.



A—Deaths in New York City on the Last Day of 10-day Periods with varying degrees of change of temperature from day to day.

Finally on the fifth day of our series (5), the air in the morning is too cold for comfort. Nevertheless, it has a sparkling bracing quality which makes everyone feel like work to a degree that is quite different from the languor of two days before. The two days when people feel least like work (days 2 and 3) are the ones when the deathrate rises. The two when they work best (4 and 5) are the ones when the deathrate is low. At all seasons the coming and going of a cylconic storm produce essentially this same effect, but the results are more evident in summer than in winter.

Inasmuch as cyclonic storms are accompanied by a double effect, partly good and partly bad, the question arises whether their net effect is helpful or harmful. One answer is seen in a comparison between deaths in New York City and the degree to which the weather varies from day to day. A347 shows the deaths on the last day of a long series of ten-day periods. The top curve represents warm weather and the bottom one cold. The left side represents periods when there was very little change of temperature from day to day, which means few storms. The right side represents extremely variable, stormy weather. In each of the five parts of the diagram light shading appears at both ends of the curved line and black shading in the middle. This means that at all seasons two kinds of weather are bad for health, and one kind is good. The bad kinds are (1) monotonous weather when there are few storms and little change from day to day, and (2) extremely variable weather when there are many storms accompanied by great changes of temperature. The good kind is weather that has a medium degree of storminess. The numbers attached to the lines show that in New York the medium periods far outnumber the ones that are so monotonous or so variable that they do harm. What this means, then, is that, although the coming and going of tropical and polar air masses in cyclonic storms sometimes do harm, far more often they are a decided help to health and activity.

On the basis of all this the optimum climate for human progress may be summed up as follows: (1) the average temperature ranges from somewhat below 40° in the coldest month to nearly 70° in the warmest month; (2) frequent storms, or winds from oceans or lakes, keep the relative humidity quite high except in hot weather, and provide rain at all seasons; (3) there is a constant succession of cyclonic storms which bring frequent moderate changes of temperature but are not severe enough to do harm. It is probable that on a cool coast such as that of California the frequent land and sea breezes, or some other condition connected with the sea, provide a factor which has much the same effect as cyclonic storms.

The Ideal Climate

We are now ready to ask ourselves what parts of the world have the best climate for man. By this we mean the best for the ordinary work of life among people like ourselves. No region on earth fully satisfies all the requirements. England and the neighboring parts of continental Europe come nearest to the ideal, but the northern United States, a narrow strip close to the Pacific Coast from California to British Columbia, and finally New Zealand fall little if any behind. In Europe the chief limitation of the region within 400 miles or so of the North Sea is that changes

of weather are not quite frequent and strong enough, and there are sometimes long periods of monotonous dampness. Southeastern England perhaps ranks highest in this region. Farther east, in Germany, the conditions are much like those of southern New England and New York except that changes are not quite so numerous or so extreme. The northern United States east of the Rocky Mountains has almost the right amount of storminess and humidity, but the summers are often too hot and the winters too cold, and the cold waves are too severe. The western coast of the United States, on the contrary, is almost ideal as to temperature and has a favorable degree of humidity most of the time, but does not have enough storms.

Although the Japanese climate cannot rival those of the regions mentioned in the last paragraph, it is excellent because of its very favorable temperature except in summer, its many storms, and abundant rain. The chief difficulty in the southern part, where most of the people live, is that the summers are too warm and especially too moist.

In the southern hemisphere, New Zealand has probably the best climate, for there are no extremes of temperature and storms are fairly abundant. The southeastern corner of Australia also has a fairly stimulating climate, as have parts of Argentina and Chile, but in these three regions cyclonic storms are not very numerous and hence there is not sufficient variability.

A Map of Climatic Energy

A352 shows how human energy would be distributed if it depended wholly on climate. Of course it actually depends also on many other conditions such as biological inheritance, food, shelter, and training, but for the present we may omit these. The parts with the two heaviest types of shading show where the climate has the greatest effect in giving people good health and making them energetic. Notice the two main dark areas in the northeast and west of the United States, and another in western Europe. The European area projects eastward into Russia. In Siberia it disappears, for many of the cyclonic storms die out, while extremes of temperature and of dryness prevail in the center of the continent. Only on the far eastern side of Asia in Japan does an Asiatic area of high, but not very high, energy appear. South of the good areas in the United States, Europe, and Japan, the conditions of health and energy decline, reaching their worst in the great deserts and near the equator. South of the equator they again improve. Probably nowhere in the southern hemisphere, however, does climatic energy rise so high as in the north, although small areas in New Zealand and Tasmania, and perhaps the newly settled southern part of Chile north of the dense for-

ests, may rank very high. From all this three main facts appear: (1) the north temperate zone of cyclonic storms is the best part of the world climatically so far as man is concerned; (2) coastal regions are more favorable than continental interiors unless the latter are helped by some special condition such as altitude or lakes; and (3) the southern hemisphere has good areas corresponding to those of the northern, but not equal to them.

Climate and Civilization

How Climate Influences Character. Health and energy have an important relation to character. Where the climate is stimulating and people's health is good, it is easy to be industrious. When people get up in the morning in such places a large number of them feel like working hard. They have the kind of energy that is needed for making inventions, trying new methods, and carrying out reforms. They do not necessarily have more ideas than others, but their energy enables them to put the ideas into practice. In an invigorating climate it is also easier to be honest and sober and self-controlled than in a more enervating one. It is much easier to speak the truth or to control one's temper when one feels strong than when one feels weak.

People who live in stimulating climates are likely to look down upon those who live in enervating climates. This is a great mistake. The effect of climate is like that of food. We do not look down upon people who are weak because they have been unable to get good food. Missionaries and colonial administrators in tropical countries have found that although religion, education, and good government may have a strong uplifting effect upon the inhabitants, it is almost impossible to overcome the effect of the climate. This simply means that will power, industry, and self-reliance depend upon health as well as upon inheritance and training.

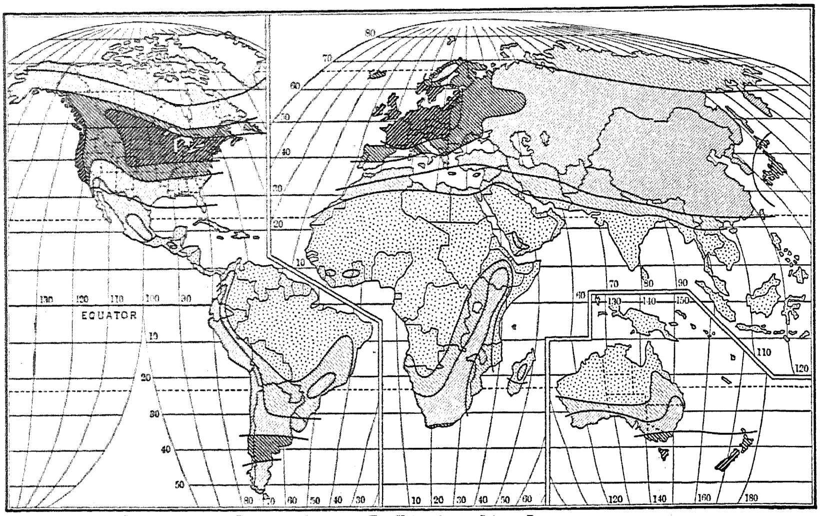
Because a person happens to be born in an unfavorable climate he is not necessarily incapable or less high minded than those born where the climate is more stimulating. In fact when a man who lives in an unfavorable climate such as that of Venezuela distinguishes himself he deserves greater credit than an equally distinguished man from a more favored region such as Louisiana, and much more than one who lives in a highly stimulating region like Ohio. The Venezuelan has to draw upon his own will power for much of his energy, while the man from Ohio is greatly helped by a stimulating climate. Thus our southern states deserve more credit for their achievements than do the northern states.

The Relation of Climate to the Distribution of Civilization. Climatic energy has much to do with the advance of civilization. B352 and A-B353 illustrate the distribution of civilization. B352 is based on the

opinion of about fifty eminent men from different countries in North America, Europe, and Asia. The heavily shaded regions contain people who stand especially high in the scale of civilization. The other two maps (A-B353) are based on statistics of automobiles and schools. The automobile map indicates the general distribution of wealth and industrial activity. The education map indicates that of the higher phases of civilization. The two are closely similar and show no essential differences from B352. Compare all three of these maps of civilization with A352, which shows climatic energy. On all the maps the darkest areas, together with the heavily shaded areas which surround them, cover approximately the same regions. They embrace most of the United States and southern Canada, most of Europe, Japan, southeastern Australia, and a portion of South America. The agreement between regions of stimulating climate and high civilization means that the health and energy imparted by such a climate provide conditions especially favorable for progress. Other conditions such as the influence of men of genius, good government, an ennobling religion, and strong institutions are also necessary just as good water, good food, and proper shelter as well as good air are necessary to health.

A Climatic Comparison: The Bahamas and Canada. To understand the relation of climate and civilization let us compare the province of Ontario, where the climate is one of the best in the world, and the Bahama Islands, which have a warm, monotonous, tropical climate. The original white settlers in both places were of the same stock. They were English colonists, many of whom left the United States at the time of the Revolution because of their loyalty to England. Today the descendants of the Loyalists in Canada are one of the strongest elements in causing that country to be conspicuously well governed and progressive. In the Bahamas the descendants of similar Loyalists are also one of the finest elements, but many of them are relatively inefficient. Among the Canadians practically everyone has a fairly good education. Among the Bahamans a large number have never been to school, and many who learned to read and write in their childhood have forgotten these arts because they do not practice them.

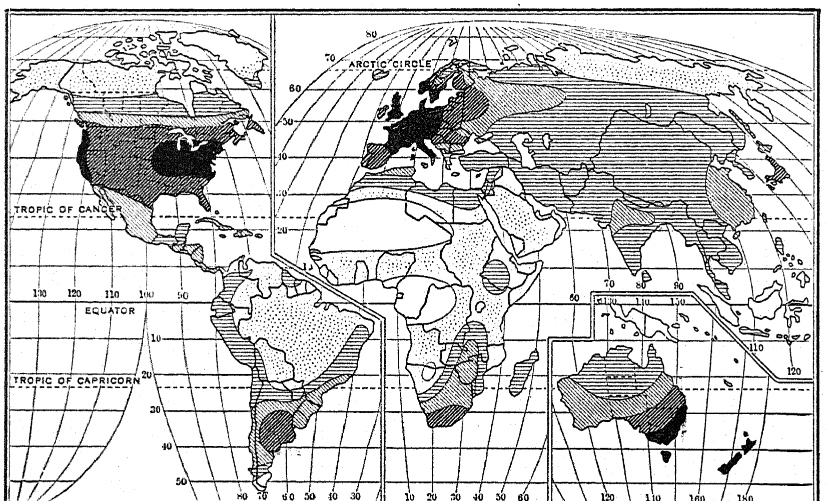
The main cause of these differences is the climate, which produces its effect partly through its direct effect on the body, and partly through indirect effects such as sanitation, disease, isolation, diet, and the clash between the Anglo-Saxon and Negro types of culture. As the Bahamans themselves say, "This climate is very healthful and pleasant as everyone knows. That is why people come from the North to spend part of the winter at beautiful Nassau. The only trouble is that it doesn't make one feel like work. In winter it's all right, although even then we can't fly



Goode's Homolosine Equal-Area Projection: Copyright, The University of Chicago Press.

A—The Distribution of Climatic Energy.

around the way you Americans do. In summer we go to bed tired and we get up more tired, and our summer lasts from April to October. It's



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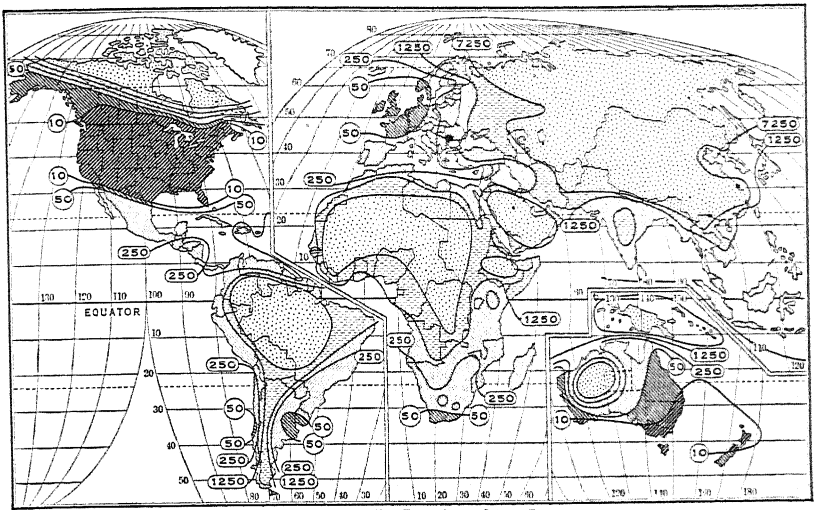
Very High   High   Medium   Low   Very Low

B—The Distribution of Civilization. Based on the opinion of fifty experts in many countries.

all very well for you Americans to think we're lazy, but try living here a year or two yourselves, and you'll be as lazy as we are." A Bahaman



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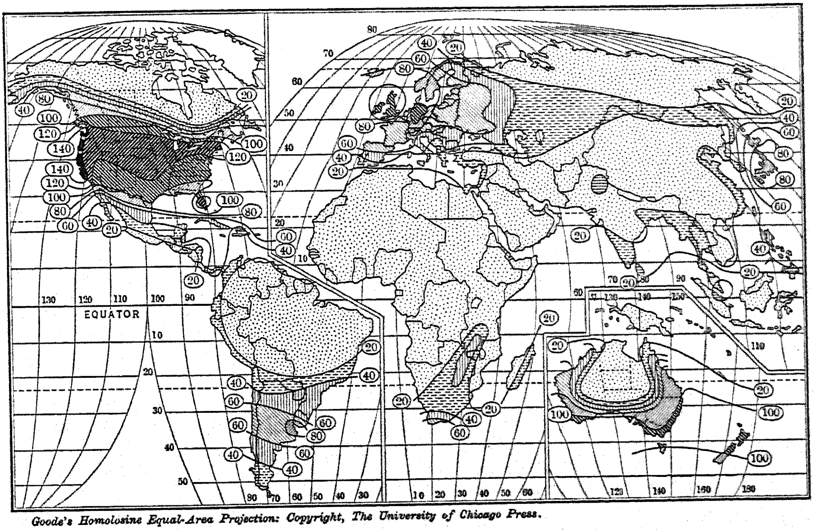
A—Persons per Motor Vehicle.



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B—Education. Persons of all ages in ordinary educational institutions per 100 children, ages 5-14 years. Russian data are doubtful, and those of some of the more backward countries are estimated.

girl who returned to the Islands for a visit after studying nursing in New York was asked whether she enjoyed life more in the United States or at home. "How can one help enjoying it more there?" she answered. "There one feels like doing things. Here one never *feels* like doing anything." The whole matter is well summed up by a local proverb which says that you cannot tell whether a Bahaman woman is pretty until she goes away and has a chance to grow plump and get some color in her cheeks. Some of the more thoughtful Bahaman parents send their children to the United States or England, not just for education, but to live permanently. They feel that the Bahamas are not a white man's country.

The chief trouble in the Bahamas seems to be the monotony of the climate. Malaria and hookworm disease, two of the chief scourges of more tropical countries, are almost unknown. The temperature is not excessive, and the hottest days are by no means so warm as in Kansas City, for example. There are few cyclonic storms, however, and therefore few changes, and little to stimulate activity. Hence, although people may have good ideas and may intend to carry them out, it is very hard to make an effort. When the Bahaman gets up in the morning he feels a sort of dullness. The regular routine of daily life can be carried on without much difficulty, but when a new kind of work is to be done, he says, "Wait till tomorrow." Civilization will probably continue to make little progress there until the Bahamans learn to overcome their climatic handicap.

The Canadian cousins of the Bahamans, on the contrary, make great progress. They are full of that superabundant energy which makes people want to get out and do something. We all know the feeling. It sometimes leads us to do foolish and even harmful things, but on the whole it keeps us profitably active and alert. This activity and alertness are one chief reason why Canada is an important member of the family of nations. The Bahaman should not be blamed for his inertia or the Ontarian praised for his achievements. Differences in climate have led to differences in diseases, diet, energy, and other respects so that progress is far harder for one than for the other.

Climate Only One of the Factors That Promote Civilization. It must not be forgotten that a stimulating climate is *only one* of the conditions which promote civilization. The world may be likened to a canvas upon which many artists are painting a picture of civilization. One artist, called climate, paints colors which may be harmonious in one place and unpleasantly lurid or faded in others. Race adds other tints, sometimes good, sometimes bad; disease and diet still others; religion adds its own special tints, and so do other phases of human culture, including industries, institutions, government, education, and other purely human inventions. If all the colors are good in any part of the world, that region will

have a high civilization. The United States and western Europe are particularly fortunate in being areas where the combination of colors is especially favorable.

Local Geography of Health

Great variations in health and hence in efficiency are often found within small areas. They are due to many causes including diet, occupations, types of clothing and shelter, economic status, and atmospheric conditions such as dust, smoke, sunshine, and ventilation. Use the mortality records of your city or county as a means of discovering whether there are any persistent differences between the deathrates of different wards of the city or townships of the county. Make a map showing the differences, and see whether you can correlate them with any of the factors mentioned above, or with the percentage of children or old people in the various sections.

Almost invariably there are decided differences in the rates of illness and death from season to season. A most interesting study can be made by plotting the deaths by months, and noting what happens in especially cold or hot seasons. If data for separate diseases are available, a decided difference will probably be found between the seasonal distribution of respiratory and digestive troubles.

The season of best health can generally be determined from the record of several years. What conditions of temperature and humidity prevail at that time?

QUESTIONS, EXERCISES, AND PROBLEMS

1. A. Keep an outdoor and indoor record of temperature as long as possible. The indoor thermometer should hang in a room where people are in the habit of sitting. The record should show the usual condition of the room, and not that when it is being aired. Keep also a record of rainfall (using a rain gauge if possible) and of clouds, fog, frost, and wind. Note the direction and force of the winds according to the following scale:

Scale Numbers	Corresponding Wind	Limits of Hourly Velocity, Miles per Hour
0	Calm	Under 2
1	Light breeze	2–12
2	Moderate wind	13–23
3	Strong wind	24–37
4	Gale	38–55
5	Storm	56–75
6	Hurricane	Above 75

B. Make notes as to days when you work especially well or poorly.

C. After your record is well started plot on a single sheet the following conditions: (1) outside temperature; (2) change in outside temperature in 24 hours; (3) inside temperature; (4) strength of the wind.

D. Study the record to see what happens both to it and to you from day to day, paying special attention to cyclonic storms and tropical and polar air masses.

2. On an outline map of the world indicate by dots the desert and semi-arid regions having a rainfall of less than 20 inches per year. Trace on this map the summer isotherm of 75° (July, A88, in the northern hemisphere, and January, A87, in the southern), putting it halfway between the 70° and 80° isotherms as shown on the maps. Insert also the winter isotherm of 20°. Now shade the lands between the two isotherms wherever the 20° isotherm lies farther from the equator than the 75° isotherm. What does your map indicate as to the extent and location of regions where neither the summer nor the winter has long-continued harmful extremes of temperature and where there is rain enough for agriculture? How would your map be altered if you made allowance for the fact that the isotherms in A87 and A88 have been reduced to sealevel, and therefore indicate temperatures much higher than really prevail in regions at high elevation (see page 89)?

Do the same thing again, using isotherms of 30° and 70°.

3. In Bartholomew's *Meteorological Atlas,* Huntington's *Civilization and Climate,* or some other book, find a map of the distribution of storms. Compare this with B352, showing the distribution of civilization, and record your conclusions.

4. On an outline map of the world indicate by a solid line the 70° isotherm for summer and by a dotted line the 70° isotherm for winter. Shade the lands between these two lines. How do the size and location of the shaded areas compare in the two hemispheres? What does this indicate as to the variability of climate north and south of the equator? Which has the advantage? Why? Compare your map with the map of civilization, B352, and draw conclusions.

5. Look up the following aboriginal people: (*a*) Kaffirs; (*b*) Bantus; (*c*) Maoris; (*d*) Australian Aborigines. Indicate on a map of the world the places where each of them was originally most numerous. What specific climatic influences help to account for the diverse abilities of the four races?

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CHAPTER XVII

THE EARTH'S GARMENT OF VEGETATION

The Importance of Plants and Animals

Thus far we have devoted our attention chiefly to the direct responses of man to the five great elements of physical environment. Beginning with the earth as a globe, we have passed directly from land forms, water bodies, soil, minerals, and climate, to man's activities. Only here and there have we touched on the plants and animals which form the second column in the geographic diagram of A4. Now that we have studied climate, however, we are ready to consider how plants and animals influence man's activities. They exert their influence chiefly through agriculture, the great industry which furnishes most of our food and raw materials.

The importance of plants and animals may be judged from the fact that in the United States about a quarter of the population depends directly upon agriculture. Someone has well said that previous to 1900 the chief manufactured product of the United States was 5,740,000 farms with an area of 840 million acres. The number of farms increased to 6,448,000 in 1920, but has now fallen somewhat. Nevertheless the amount of land in farms has increased to about 1 billion acres. About 360 million acres are harvested each year, but this is reduced to about 290 million if we exclude hay. The amount of cultivated land is not increasing now because we export less food and use fewer horses than formerly. Moreover, the greater part of the good land has already been occupied. Nevertheless, in 1930 the farms of the United States, including buildings, equipment, and animals, as well as the soil where the crops are grown, were worth about 57 billion dollars. This is more than the capital invested in manufacturing enterprises in this country. The number of people who live on the farms is about the same as the number who depend on manufacturing, provided we exclude the building industry.

Even in a country like England, where manufacturing is predominant and home production of food does not begin to supply the demand, agriculture employs more people than all the railroads, steamships, and other means of communication, and more than the metal industries which have made British cutlery and other hardware famous all over the world. Else-

where agriculture is still more important. In Russia three fourths of the people are peasants; in India and China the proportion is even larger. Thus plants and animals, through agriculture, determine the mode of life and the prosperity of at least three fifths of the world's inhabitants.

How the Nature of the Vegetation Determines the Character of Agriculture

Although the farmer uses both plants and animals, plants are much the more important because animals as well as men depend upon them for food. The full importance of plants, however, does not appear until we also realize that the differences in agriculture from region to region depend largely on the different kinds of plants which the climate and soil permit. The man who clears the tropical jungle cannot possibly raise the same crops as the one who lives in the far north where a growing season of only three months permits little save barley to be raised. Nor can he plant and reap his crops in the same way, or use the same variety of animals. So, too, the man who lives in the fertile grass lands of the prairie raises corn, wheat, horses, and cows, while the one who inhabits a hot desert oasis raises millet, dates, camels, and goats. What the chestnut and olive are to the Spanish peasant, the breadfruit tree is to the scantily clad inhabitant of the tropical Marquesas Islands in the South Pacific. Even in the same latitude the parts of Yucatán that favor the growth of sisal give rise to a kind of farming different from that which prevails in the wetter regions where rubber trees and cacao thrive. The Lapp who raises reindeer does so because the vegetation that will grow in his cold northern region will support few other highly useful kinds of animals, and will not furnish crops that man can eat. In all these cases vegetation is the chief factor in determining how the people get a living.

The Three Great Types of Vegetation

Since plants are the most important factor in the lives of such a vast number of people, we must understand the variations of natural vegetation and the causes of their distribution. The ordinary plants that form the earth's garment of vegetation may be divided into three great groups: (1) trees; (2) bushes, scrub, and woody perennials; and (3) grasses and other herbaceous forms. Without this varied garment of vegetation the lands of the earth would be as barren as the moon with its wastes of desolation. While soil and relief have much to do with the local distribution of these three groups, their general distribution over the world as a whole depends chiefly upon two climatic factors: (*a*) the length of the season warm enough for growth; and (*b*) the proportion of that season during which there is moisture enough to promote growth.

Trees. Although trees are the largest form of vegetable life, they are in many ways more sensitive than bushy or grassy vegetation. As a rule they are sensitive to drought, especially when young. In traveling from a well-watered region to one that is dry one sees the trees diminish in size and become scrubby, or else become few in number and limited to areas that are usually damp. Most trees also need a fairly long growing season. That is why the treeline on mountains is lower than the upper limit of grasses. On the higher slopes of the mountains, although there is plenty of moisture, the warm period when growth is possible is so short that quickly growing grasses have a great advantage over slow-growing trees and can drive them out. Accordingly the regions in which trees attain a fine growth and form great forests generally nave a moderately long warm season with fairly abundant moisture. Such regions may be as varied as the Belgian Congo, Siberia, the eastern United States, and the Andes of southern Chile.

Bushes and Scrub. The plants classified under this head range all the way from scrubby trees to perennials with more or less woody stems which die in part after each growing season. Such plants are mixed with the trees in most forested regions. Where the conditions of climate or soil become unfavorable to trees, however, bushes crowd them out and become the chief growth. This can be seen near the treeline on the sides of mountains where low temperature hampers the trees more than the bushes. It is also seen on the edges of swamps where too much moisture in the soil prevents many kinds of trees from growing, but does not drive out the bushes. Again where the soil becomes thin, and hence dry, the trees give place to bushes. The most noteworthy habitats of bushes are subtropical and desert regions, or the parts of the torrid zone where the dry season is particularly long, that is, the Wet and Dry Low Latitudes. The mountains of Sicily with their scrubby "dry forests," the sagebrush desert of Utah, the bushy desert of Arizona, and the areas of tropical scrub in the dry parts of Colombia are all examples of this type.

The bushes, shrubs, and trees of dry regions are well fitted to maintain themselves through protracted droughts provided they have water at occasional intervals. Many of them have drought-resistant leaves. In some, like the laurel and live-oak, the leaves are hard and shiny; in others such as the sage, they are soft and furry. Both types have coverings that hinder evaporation and thus protect the plants during the long dry season. Many such plants also bear prickly leaves or spines. These incidentally protect the plants against the ravages of animals, but in most cases they originate through a progressive reduction in the plant's evaporating surface. The plants in which evaporation is restricted have the best chance of survival in the desert.

Grasses. The modest grasses grow under a greater variety of conditions than do either trees or bushes. They are supposed to be a relatively new form of vegetation characterized by special powers of adapting themselves to all sorts of extreme conditions. Many grasses can complete their growth and mature their seeds in a few weeks, so that a single shower in the desert may be enough for them; others can thrive on high mountains where the warm season is too short for trees or bushes. Hence above the treeline lofty green pastures or "alps" furnish food for sheep and cattle in Switzerland, Norway, and elsewhere. Grasses can also endure excessive moisture which would be fatal to trees and bushes, as on the dripping hills of Ireland, Scotland, and Wales, and the soggy marshes of Holland. Wherever other forms of vegetation are at a disadvantage as in deserts, steppes, and regions with short seasons or much cool moisture, grasses are likely to oust them.

A Mountain Showing the Three Main Types of Vegetation. A most interesting illustration of the relation of climate to trees, bushes, and grasses is found on the western slope of the Sierra Nevada in California. At the base the climate is so dry that the traveler finds the plain and the lower foothills clothed with grass which is green only a few weeks. A little higher up, where the rainfall increases, bushy vegetation of many sorts is met, including the wild lilac, the yucca with its tall stalks of greenish white flowers, and the manzanita, with its smooth hornlike stems. The live-oak tree with its hard, prickly leaves appears, and before one has climbed far he is in the midst of a dry forest, that is, one composed of drought-resistant trees many of which are scrubby. At higher altitudes, where there is abundant rain, the dry forest is replaced by a wet forest of broad-leaved trees like the ordinary oak and sycamore. Then, where the air is colder, the type changes to coniferous forests of pines, giant sequoias, spruces, and firs. Next, where the growing season becomes too short for trees, one struggles through a dense thicket of bushes bent down by six months of snow each year. Finally, the open grassy slopes of the "alps" are reached, for here, where the temperature is too low for other plants, the grasses thrive far better than they do in the dry, hot desert far below. Thus within a day's climb one may find most of the world's main types of vegetation.

Distribution of Vegetation on a Simplified Globe

The distribution of trees, bushes, and grasses over the earth's surface seems at first sight to be most complicated. It follows definite laws, however, as may be seen from a comparison of the accompanying table with A363 and with Plate II. The table shows how vegetation would be distributed on a simplified globe, such as we have used in discussing climate.

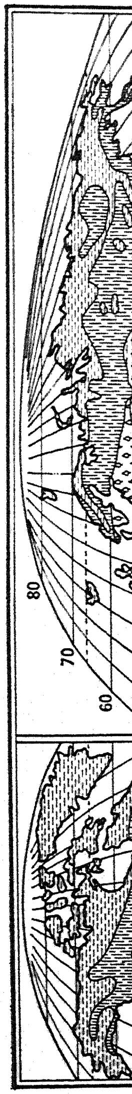
IDEAL DISTRIBUTION OF VEGETATION AND CIVILIZATION ON A SIMPLIFIED GLOBE

Type of Vegetation	Approximate Latitude	Climate	Density of Population	Condition of Civilization	Examples: A Foreign	Examples: B United States and Its Dependencies
(1) Equatorial rain-forest	0–7°	Always hot and moist	Sparse	Very low	Amazon Basin	Panama Zone, South Philippines
(2) Tropical jungle	7–15°	Always hot; long rainy season, short dry season	Dense	Low	Southern India	Puerto Rico, Virgin Islands
(3) Tropical scrub	10–20°	Always hot; long dry season	Moderate	Low	Northern edge of Yucatán	
(4) Savanna grass-land	15–25°	Always hot or warm; dry season and wet season	Moderate	Low	Sudan	Small parts of North Philippines
(5) Desert	20–35°	Always dry; warm winter, hot summer	Sparse	Very low to high	Arabia	Nevada
(6) Subtropical dry forest	30–40°	Cool, moist winter, but hot dry summer	Moderate	Medium to very high	Spain	Southern California
(7) Prairie	35–45°	Cool dry winter, hot rainy summer	Dense	High or very high	Hungary	Iowa, Illinois
(8) Deciduous forest	42–55°	Cold snowy winter, hot rainy summer	Dense	Very high	England, France	New York, Pennsylvania
(9) Coniferous forest	55–65°	Long, cold, snowy winter; short, warm, rainy summer	Moderate	High to low	Northern Sweden Much of Siberia	Northern Maine, Northern Wisconsin
(10) Tundra	65–75°	Long, cold, snowy winter; short, cool, rainy summer	Sparse	Very low	Northern coast of Canada	Northern Alaska
(11) Polar desert	75–90°	Mostly winter	No people	Absent	Northern Greenland	

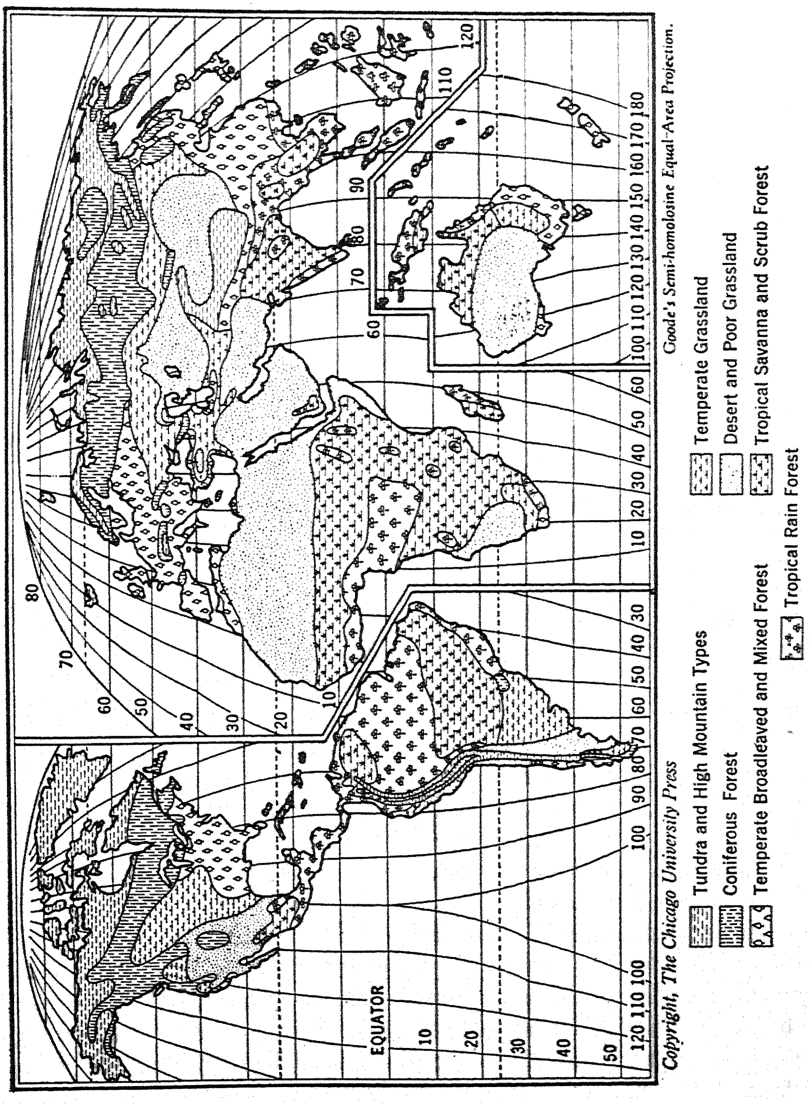
A363 shows, in a general way, the actual distribution. Plate II also shows vegetation, but there the world has been divided into natural regions on the basis of man's use of the soil and the nature of the climate, as well as on the basis of vegetation. By comparing the maps with the table we can see how the distribution of plants is affected not only by the zonal arrangement of temperature and moisture on the earth's surface, but also by the relief of the lands, and especially by the presence of moisture. Far larger areas bear sparse vegetation because of aridity than because of low temperature.

(1) *Equatorial Rainforest.* Close to the equator a simplified globe would be surrounded by a zone of the densest kind of equatorial rainforest. It is called the *rainforest* because the dry seasons are here so short that the ground never becomes parched, and most of the year there is a superabundance of moisture. As the temperature is always high, vegetation can grow rapidly at all times. The trees rise to great heights and form a somber canopy which shuts out the sunlight. The forest is mostly uninhabited, and the few people who dwell in it are mainly uncivilized savages like those of the Amazon Basin. On the map this kind of forest does not form a continuous equatorial belt, because it is interrupted not only by the oceans but also by mountains and plateaus. Nevertheless it covers vast areas in the Amazon and Congo Basins and in the East Indies and the Malay Peninsula, as is evident in Plate II where it is No. 1. Smaller outlying areas of similar forest are found on the rainy east coasts of Central America and Brazil, on the west coast of India and at the base of the eastern Himalayas.

(2) *Tropical Jungle.* Poleward of the tropical regions, approximately in latitudes 7° to 15°, the rainfall on a simplified globe, though still abundant, would diminish and the dry season become longer than at the equator. Hence the equatorial rainforest would give place to the kind of forest called tropical jungle. Many of the trees in such a forest are of large size. More, however, are moderate in height, and in some of the drier parts bushes become abundant. The chief characteristic of the typical jungle is the way in which vegetation runs riot. The plants crowd upon one another so closely that a person unskilled in the lore of the forest may lose himself in five minutes. This is the part of the world where it is easiest for man to get a living, and where most of the world's tropical plantations are located. Hence, in the cleared portions, the population is often dense, but the people do not stand high in civilization. In A363 the jungle is not separated from the rainforest, for on the varied surface of our earth the two are often intermixed. In general, however, the type here called jungle lies on the margins of the rainforest and in small strips here and there. It covers what are called the regions of Wet Tropical



Agriculture in Plate II (No. 2). In America the jungle regions comprise large areas in Central America and the northern part of South America, together with southeastern Brazil. In Africa there is a good deal of jungle



A—The Distribution of Natural Vegetation.

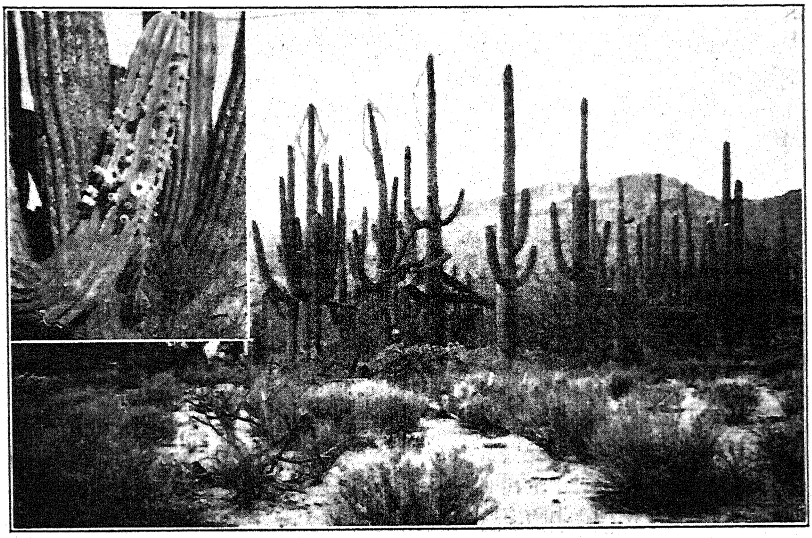
on the borders of the equatorial forest and also in Abyssinia, Madagascar, and along the eastern coast, but owing to the high altitude the proportion of jungle is less than in other tropical regions. In Asia, the best examples

of jungle are in southern India and Indo-China. Not far away the drier parts of the East Indies and a small section of northeastern Australia also contain jungle regions.

(3) *Tropical Scrub.* Although equatorial rainforests and tropical jungle are often supposed to be the two most typical kinds of vegetation in the warmest parts of the earth, tropical scrub and grassland occupy still larger areas. Both of these are more or less mixed with the jungle and with each other by reason of variations in soil, altitude, and relief. Rivers, for example, are often bordered by what is called a gallery forest composed of genuine jungle or rainforest. Large areas away from the rivers consist of grassy savanna where grass 3 to 12 feet high alternates with patches of thorny, open forest. On a simplified globe the scrub would form a band in each hemisphere at a distance of 10° to 20° more or less from the equator. There the jungle diminishes in height and vigor because of the increase in the length of the dry season as one gets farther from the equator. In actual practice, however, the distribution is much more irregular, as appears in A363. In the scrub regions the bushes are green during the wet half of the year, but lose their leaves during the dry season and look like a second growth in an American woodlot late in the autumn. Occasionally, however, a bare bush covered with great red, white, yellow, or purple flowers makes one realize that he is within the tropics and only 10° to 20° from the equator. Areas of tropical scrub occur in many parts of southern Mexico and Central America, central and southern Africa, the drier parts of the plateau of India, and the northern portion of Australia. They are included in the Wet and Dry Low Latitudes of Plate II, for a warm dry season is the climatic factor which prevents the growth of bigger types of forest. Although civilization is low in such regions, it is often higher than in the tropical rainforest, and sometimes higher than in the jungle zone with its tropical plantations, as appears in Yucatán and the northern part of the Deccan Plateau in India.

(4) *Savanna.* As one proceeds away from the equator on a simplified globe, the scrubby brush lands gradually give place to broad grassy areas. Sometimes these are dotted with clumps of trees or bushes, the outposts of the forest and the scrub. In other places they are absolutely treeless except along the rivers. The "pampas" of Argentina and the "llanos" of Venezuela are some of the best-known savannas. In central Africa among the highlands and farther north in the great plains of the Sudan, similar grasslands are developed on a vast scale, while in northern India and northern Burma they occur in large patches. The parts of such savannas where trees alternate with grass are almost ideal for big game. The trees furnish shelter, while the grass furnishes food for innumerable animals such as buffaloes, antelopes, giraffes, zebras, elephants, and many smaller

herbivorous species, which in turn supply food for lions, tigers, leopards, and other carnivores. For man, however, the savannas are not so good. The grass, to be sure, furnishes food for cattle, although it is apt to be much tougher and less nutritious than the grass of more northern regions. In the long dry season, in many places, water can be procured only by digging wells of extreme depth. The sod is so tough that it is difficult to plow. Hence many of the natives of tropical grasslands wander with their cattle. A good example is the Kaffirs of South Africa, among whom prices are reckoned in cows. Many tropical highlands also have



A—A Desert Forest in Southern Arizona.

Suhuaro, or Giant Cactus, with smaller cacti, greesewood bushes, etc., below them. Beautiful white flowers of the suhuaro in upper corner.

large areas of grasslands, and these are among the best parts of the tropics, as may be seen in the plateau around Mexico City.

(5) *Deserts.* Poleward from the grasslands the desert begins. Usually there is no sharp transition, for the grassland, and sometimes the scrub, gradually diminish as one passes into regions where the equatorial rain belt has less and less effect. On a simplified globe the deserts would be most pronounced between 25° and 30° from the equator, where the subtropical area of high pressure and the tradewinds prevail alternately according to the season. On the actual earth, however, deserts occupy these latitudes only on the western sides of the continents, while rainy monsoon areas lie on the east. To make up for this, as it were, the deserts extend

into much higher latitudes in the interior of the continents, especially in Asia.

Both grasses and bushes are found in deserts. The plants which support such wandering people as the Arabs consist of grasses and other small herbaceous forms which sprout quickly after the infrequent rains, remain green only a few weeks, and then quickly wither and disappear so that one would never know they had existed. In most deserts, however, there is also a more permanent type of vegetation, consisting of little bushes spaced far apart so that each has a large area where it can spread its roots horizontally and thus get as much water as possible from each infrequent shower. Some types, which grow in hollows, form what may be called an inverted forest, for the roots reach far down to groundwater, and are so large that they form as it were an underground forest, far bigger than the small plants that rise above the surface. Throughout much of the desert, however, the water table, or level of permanent groundwater, lies so far below the surface that plants are unable to reach it.

Although the total number of plants in a desert is small compared with moister regions, the number of species is large. Not only are there the relatively long-lived bushy types, the temporary grasses, and the other herbaceous forms which grow up quickly after rains, but moist spots support the kinds of vegetation that grow in regions of abundant rain, while the salt lakes are surrounded by species similar to those that grow on the seashore. In addition to this the desert is full of highly specialized plants, like the cactus, adapted for storing large quantities of water. The cactus can retain water so long that specimens which were pulled up by the roots and hung in a dry place for eight years still retained half as much water as at the beginning. The desert of northwestern Mexico is the home of a curious, almost leafless bush somewhat larger than a currant bush. Its stout, tapering stems are covered with a glossy bark and look hard and woody. When a twig is cut, however, the knife goes through it easily as if it were made of wax, and drops of sap begin to fall almost in a stream. The bark is waterproof, but wherever it is broken the stored water oozes out rapidly. Because of the necessity of adapting themselves to extreme aridity, many of the genuine desert plants are peculiarly awkward in appearance. Their fat, hairy stems, their spines, and their fuzzy or leathery leaves seem uncouth compared with the graceful vegetation of moister regions.

(6) *Subtropical Dry Forest.* On the cooler borders of the desert, especially on the western side of the continents, the vegetation in latitudes 30° to 40°, or higher, consists of subtropical dry forest, the Mediterranean type (No. 7) in Plate II. This is also found on many mountains which rise within the desert itself. It is composed of small, gnarled, hard-leaved

trees or bushes which often form open parklike expanses through which it is easy to travel. In some places, however, they graduate into a tangle of bushes above which rise frequent trees. For example, along the southern coast of Asia Minor the lower mountains are clothed with scattered trees and occasional bushes which give an open, friendly aspect like a park. Higher up, however, toward the level where the coolness and moisture of the mountains cause them to be clothed with pine forests, there is a bushy belt almost impossible to cross. The subtropical trees which make up the dry forest, although not conifers, are likely to be evergreens like the laurel, olive, holly, and live-oak. This is an advantage, because the winter temperature in these latitudes is often quite high and, as the rain comes chiefly in winter, the trees can grow even at that season. This makes up in part for the dry summer when growth must cease.

(7) *Prairie.* In the table on page 361 a belt of prairie or steppe is shown in latitudes slightly higher than those of the subtropical dry forest. As a matter of fact, subtropical dry forest, desert, prairie, and deciduous forest all occur in the same latitudes in both North America and Eurasia (Plate II). The forests occur near the coasts, and the deserts and prairies in the interior. The distribution of prairies depends on the season of rainfall and the kind of soil. Grasses are such assertive, tenacious plants that they can drive out the trees in places where trees could grow if nothing else interfered with them. Thus large parts of the American prairies and the steppes of Russia and Hungary are located in regions where certain kinds of trees can flourish if they are protected when young. The grasses, however, because of their more rapid growth and greater hardiness, have driven out the trees. Over most of the prairie region the rainfall is likely to be deficient not only in winter, so that the ground is dry when the temperature becomes warm enough for growth, but also in the spring when the trees especially need it. Hence when seedling trees begin to grow they are at a disadvantage and are strangled by the more rapidly growing grasses. If such a region is swept by fires or is grazed by herds of animals like the buffalo, the grass and seedlings both suffer, but the grass springs up again in a few weeks, while the young trees must start from new seeds and hence are ousted in the long run. Because of their stimulating climate and rich soil, the prairies hold high rank in both agriculture and civilization, as is shown by our own Middle West. In Plate II the true prairies, as distinguished from steppes where the grass is shorter, are counted as parts of the cyclonic regions (10 and 10A).

(8) *Deciduous Forests.* In the eastern United States and western Europe the prairies give place to deciduous forests. These are composed of trees like the maple, beech, oak, and poplar, that drop their leaves in the autumn. Often these trees are mixed with conifers like the pine. This

mixed forest grows in places where the winters are cold but not extremely long, and where the summers are warm, or even hot for a while, and have plenty of moisture all the time. These are the regions of cyclonic storms and of abundant rains at all seasons. The regions of deciduous forests are so excellent for men that they have been largely cleared. Today they support some of the world's densest populations and contain the great manufacturing centers and the countries that stand in the forefront of civilization.

(9) *Coniferous Forests*. In an average latitude of about 50° the other types of vegetation merge irregularly into vast forests of spruce, fur, pine, hemlock, and similar coniferous trees which thrive where the winters are long and cold, and the summers fairly warm and rainy, though short. This evergreen forest forms a great belt across Canada and another from Sweden through Russia and Siberia. On the whole the coniferous forest is too cold for agriculture. Hence it has been occupied by settlers only in the southern portions. The rest still stands as the world's greatest forest reserve outside the tropics. Where the coniferous forest region is inhabited, the people are generally in a high state of civilization along the warmer margin, but rather low, like the Canadian Indians, farther north.

(10) *Tundra*. Nearer the poles the coniferous forest gradually breaks down into a belt of bleak tundra. This is often spoken of as grassy, but as a matter of fact it contains vastly more lichens than grass. No agriculture is possible. The reindeer, caribou, and muskox, however, can get a living, though they must often paw away the snow to get at the plants beneath. Hence, civilization is very low, as we see in the extreme northern part of Asia and North America.

(11) *Polar Deserts*. Near the poles in latitudes above 75° the temperature is almost everywhere so low that the snow does not disappear in time to permit much vegetation other than lichens that cling to rocks, or minute bacteria of various forms. Yet the prolonged sunlight provides such steady warmth that beautiful flowery vegetation can be found in small isolated patches with sunny exposures. Nevertheless, this region as a whole consists of polar deserts like Greenland and Antarctica, which are wholly devoid of inhabitants.

It is worth noting that in polar deserts it is not the temperature alone which prohibits the growth of plants. The long period when the ground is frozen prevents the plants from getting enough water. There is no way in which loss of water by transpiration can be balanced by absorption of water through the roots.

The Vegetation Around Us

One of the most profitable ways of studying local geography is based on vegetation. A walk on a country road can be made uniquely interesting by mapping the vegetation on the two sides of the road. The cultivated tracts can be classified according to their type—hay, cereals of various kinds, potatoes, other vegetables, and orchards, for example. The uncultivated tracts can be classified into pasture, scrub, coniferous forest, deciduous forest, swampy plants, and certain special kinds such as the plants that grow on rocks. The most interesting part of the work is to discover reasons why some tracts are cultivated and others left to nature. Soil, slope, distance from roads or houses, number and size of stones in the soil, and the degree to which water stands on the land or runs away too quickly are factors to be considered. A talk with a farmer often brings out interesting points. Sometimes mere habit leads a farmer to use his land for types of vegetation which are not the most profitable. On the other hand, long experience enables farmers to judge what degree of slope or what quality of soil renders a tract fit for pasture, for example, but not fit for crops. The type of vegetation on a farm can often be used as a means of measuring prosperity.

Even in a village or the suburban parts of a city a profitable local study of vegetation can be made. Examine again the vegetation on newly exposed soils which were discussed in a previous chapter. The plants that grow beside the road on minor streets that are not yet built upon vary in type according to the soil and slope. Some lawns look much greener and richer than others. Is it because of good soil, good seed, abundant water, or abundant fertilizer? On your own lot there may be places where the vegetation varies because of little climatic differences due to shading and exposure, or because of original differences in the soil, or the way in which the soil has been altered in the work of building houses, driveways, and so forth. In many museums one can study specimens of diverse types of vegetation. In photographs it is sometimes of interest to identify the types of vegetation. Sometimes one can determine whether a painting shows the type of plants appropriate to its supposed location.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Classify the types of vegetation in the country around your home according to A361. What effect have the various types upon man's life?

2. Use census data in order to draw a graph showing the approximate percentage formed by each of the following in your county: (*a*) land in crops; (*b*) grassland; (*c*) uncultivated pasture; (*d*) productive woodland; (*e*) waste land. Explain the geographic conditions which give rise to these proportions.

3. Make as full a classification as possible of the different kinds of trees in your vicinity and of their uses. Roughly speaking, what percentage lose their leaves in winter?

4. Classify the main crops of your state according to their uses and according to the kind and amount of land which they occupy. Census returns will give you the necessary data.

5. It is often stated that the lack of forests in China is due to the constant cutting of the trees and that this had led to a change in climate. Modern research gives little support to the idea that deforestation causes climatic changes. What do you conclude as to the cause of the absence of forests in China, taking into consideration the following facts: (*a*) length of growing season in northern China (A87, A88); (*b*) the relation of tree growth to rainfall in spring, summer, and autumn, respectively; (*c*) the fact that southern China has many trees while northern China has few; (*d*) the relative density of population in North and South China (A144 and A225); (*e*) the fact that eastern Kansas, with its summer rain and winter drought, is treeless, while England, with no more rain but a different seasonal distribution, has many trees.

6. "Wheat is merely a cultivated grass and will grow anywhere on the natural grasslands of the earth." Examine the truth of this statement. Test it by superposing two maps, one showing the natural grasslands of the world and the other the areas of wheat production. A written interpretation should accompany your map.

7. A few years ago numbers of advertisements appeared in England emphasizing the advantages of rubber plantations in Burma. Study the climatic maps and find out whether the climatic conditions justify such advertising.

8. From A107 estimate the relative areas where vegetation is seriously restricted by aridity versus temperature. How does each type of restriction influence transportation and interfere with the general intercourse of the different parts of the world?

9. In the text savannas receive more space than prairies, deciduous forests, or coniferous forests. On which of the following grounds is this justifiable: (*a*) degree of familiarity to the average reader, (*b*) amount of space actually covered as shown in A363, (*c*) importance to civilization?

PART VIII

MAN'S REGIONAL RELATIONSHIPS

CHAPTER XVIII

THE POORER TROPICAL REGIONS

A. Life in the Equatorial Rainforest

Tropical Diversity

One of the most remarkable facts about tropical countries is their extreme diversity. They differ from place to place much more than do regions in middle or high latitudes. One reason for this is that as one goes from sealevel upward among tropical mountains one finds all sorts of climates and their characteristic plants and crops. At sealevel there is a profusion of tropical plants, which are not found in any other climatic zone. At an elevation of a few thousand feet, plants of the temperate zone begin to be mixed with the tropical varieties, and then become dominant. At high enough altitudes pine woods suggest those of Michigan and Wisconsin. Then, while one is still only a few miles from the palms, bananas, and lianas of the coast, one finds alpine grasses and flowers. Above these the lichen-covered rocks and snowy peaks look like high polar latitudes. Of course one does not find much difference in the length of day and night within the tropics, and the noonday sun is always scorching hot. Nor does one there find climates with the stimulating quality of the cyclonic type, even though the temperature at altitudes of 3,000 to 6,000 feet is delightful. Nevertheless, in order to find as great a variety of vegetation as one sees in a climb from sealevel to 18,000 feet near the equator one would have to travel northward or southward 4,000 miles or more at sealevel.

In addition to this, even near sealevel, the contrasts from place to place because of differences in soil are especially great in low latitudes. The poorest tropical soils, such as the red laterites, are more thoroughly leached and more hopeless for agriculture than almost any soils in other latitudes. The best volcanic or alluvial soils, on the contrary, yield an extraordinary variety and abundance of products, provided the rainfall is right.

Tropical regions also vary enormously because of the amount of rain, and especially the length of the rainy and dry seasons. This leads to the greatest possible contrast in vegetation, namely, the contrast between the magnificent rainforest and the insignificant little grasses on the equatorward border of deserts such as the Sahara. Winds, too, are peculiarly important within the tropics. In its effect on men a tradewind climate, such as that of Hawaii on the edge of the tropics, differs from an equatorial inland climate, such as that of Manaus on the Amazon, more than it does from that of London. Thus, when differences of altitude, soil, rainfall, and wind are combined, the contrasts within the tropics are greater than in any other part of the world. It is absurd to talk about *the* tropical climate. There are many tropical climates.

Types of Tropical Regions

The four most important types of tropical regions differ greatly in extent and usefulness. Unfortunately the two most valuable types cover a relatively small area, and two types that are of little value are widespread. On Plate II read the descriptions and note the distribution of the types numbered 1 to 4. The two types that are of little use are the Equatorial Rainforest (1) and the Wet and Dry Low Latitudes (3), which we shall here call the Scrub Forest and Savanna Type. The Equatorial Rainforest occupies a vast area in the Amazon Basin and an almost equally large area in Central Africa. Smaller patches occur in Central America, Mexico, Liberia, and neighboring parts of western Africa, as well as in Central India, Burma, Indo-China, and the East Indian islands such as Sumatra, Borneo, and the Philippines.

Bordering the Equatorial Rainforest we usually find either large tracts of the least valuable type, namely the tropical Scrub Forest and Savanna described in Chapter XV (No. 3 in Plate II), or else smaller strips of the most useful kind of tropical area, namely, Wet Tropical Agricultural Regions (2). In the transition zone where the big rainforest gradually gives place to the orchardlike scrub forest, there is usually a jungle zone, and this is properly part of the region of Wet Tropical Agriculture. It is too irregular in shape and often too small to be shown in Plate II, but it must be carefully taken into account. It supports a good share of the tropical people.

Pick out the Tropical Scrub Forest and Savanna (Wet and Dry Low Latitudes) in Plate II. Note their vast size in Africa, and the way in which they surround the Equatorial Rainforest, and are broken by islands of Wet Tropical Agriculture (2) and Cool Tropical Highlands (4). In South America another huge area of scrub forest and savanna, almost as large as the United States, is broken into two main parts, and is bordered

by Regions of Wet Tropical Agriculture. To the west of it small areas of Cool Tropical Highlands appear as dark patches in the midst of High Mountains (the Andes) of the kind numbered 13 in Plate II and indicated by little circles. In Asia Tropical Scrub Forest and Savanna occupy nearly half of India away from the coasts, and occur in southwestern Arabia, Burma, and Siam. Northern Australia has an area of this same relatively poor kind bigger than Germany, France, and Great Britain combined. North America, however, has only a little in northwestern Mexico.

A map such as Plate II is highly generalized because of its small scale. A larger map would show that the four types of tropical natural regions are even more intricately mingled than appears in Plate II. Nevertheless, except in North America (and, of course, Europe, which has no tropical section) the two most extensive and least valuable tropical types, Equatorial Rainforest and tropical Scrub Forest and Savanna, form vast areas with little interruption from the more favorable types. The two more favorable types, however, are the ones from which most people gain their impressions of the tropics. This is natural, because they are the places where people mainly live, and therefore the ones which northerners visit and about which we chiefly read. We must carefully note, however, that the two less favorable types are by far the most extensive.

Equatorial Rainforest

It seems strange that the finest vegetation should be associated with the most backward types of men. Yet such is the case in the Equatorial Rainforest, where high temperature is accompanied by abundant moisture at practically all seasons. The trees are often so huge and leafy that their lofty tops form an almost unbroken canopy through which the sun rarely shines. In these dense forests the trees are often covered with bright-colored parasitic plants, while long vines, or lianas, hang down like great living ropes. Near the ground there is little vegetation except where the death of an old tree has left an opening. There hosts of young plants grow so fast that they seem to be racing, the prize being life for those that attain dominance, and death for the rest.

Handicaps to Health. In such regions and also in the parts where the jungle type of vegetation prevails, man is subject to serious handicaps. He has little energy, because the damp, steady heat never changes and never invigorates. He suffers terribly from malaria and other tropical diseases. When ground was being broken for a railroad in the forest of eastern Guatemala the management dared not keep the West Indian laborers at work more than two or three weeks at a time. A longer stay would

almost surely have led to death from malignant malaria, and even as it was, many died.

Along with the trying climate and disease go a host of insect pests and other little irritations. In Liberia, as a long resident puts it, moths eat up clothing; cockroaches devour bookbindings and swarm in a detached cookhouse which takes the place of a kitchen; rats climb to seemingly inaccessible locations and leave nothing but the fragments of the treasures they have eaten; white ants consume the sills of houses and the rungs of chairs, which collapse most unexpectedly; driver ants sweep through the house, and every other creature from man to lizard must vacate even if it be in the midst of rain and the dead of night; "jiggers" bore under the skin of the foot and lay their eggs; fleas bite; the damp heat produces rash against which the lightest clothing feels like nettles. These things and a hundred others are irritating enough at any time, but through the blur of a "touch of sun" or the haze of a burning fever they assume proportions out of all reason. The odors, the mists, the sights, the sounds get on the nerves; the heavy, drooping, silent, impenetrable green forest everywhere shuts one in like a smothering grave; the mind grows sick, and the body follows. Yet the forest is often surpassingly beautiful. If no exertion is needed the temperature is merely enervating and not especially uncomfortable, for it often rises no higher than 85° in the deep shade of the forest. The warm rain feels most soothing as it falls on the head and shoulders. It is the hot, damp, sleepless nights and the parasitic diseases and insects which wear people out.

Scarcity of Beasts of Burden. A second great handicap in equatorial rainforests is the difficulty of keeping domestic animals even in the clearings. Noxious insects plague animals almost as badly as they plague man. For example, in large parts of tropical Africa the bite of the tsetse fly not only causes the deadly sleeping sickness in man, but also is fatal to domestic animals, for even the donkey is not immune. Even if animals escape disease, they rarely thrive, for what little grass can grow among the luxuriant trees is usually so rank and coarse that it is not nutritious.

Difficulty of Transportation. The difficulty of keeping domestic animals emphasizes another great handicap of the equatorial forests, namely, the difficulty of transportation. If the natives attempt to travel through the forest without roads, they encounter swamps, great projecting roots, dense thickets, and other obstructions as bad as anything our ancestors met when they first settled in America. They are also likely to be attacked by snakes, as well as poisonous insects. Suppose that someone has energy enough to clear away the forest for a road. New plants spring up almost overnight, and grow 10 to 20 feet in a year. The map of Quintana Roo, the densely forested and almost uninhabited southern part of the

Yucatán peninsula, for example, shows a number of roads, but when a traveler wishes to follow them he is told that they do not exist. They were kept open a few years when *chicle,* the sap from which chewing gum is made, was being gathered, but when this work was finished the trails became smothered in vegetation within two or three years. A macadam road or even a railroad may suffer the same fate, although more slowly. On the railroad that runs from the Gulf of Mexico to the Pacific Ocean across the Isthmus of Tehuantepec, for example, men must be employed to cut the bushes every few months. Where communication is so difficult, people naturally profit little by intercourse with others who bring new methods and ideas. The equatorial forests and jungle which begin on the eastern slope of the Andes do much to prevent Bolivia, Peru, Ecuador, and Colombia from using the Amazon River and its many great tributaries for communication with the Atlantic side of the continent, and so with Europe. When Colombia and Peru had a quarrel over the riverport of Leticia on the upper Amazon, it was easier for Colombia to send troops around South America through the Panama Canal and up the Amazon rather than through the forest that mantles the eastern slope of the Andes.

Difficulties of Agriculture. Another and even greater handicap of the equatorial forest is the difficulty of carrying on agriculture. When our forefathers cleared the forests of America their task was child's play compared with the clearing of an equatorial forest. They encountered smaller trees than those of the tropics, and also they cut pine, birch, beech, and other relatively soft woods most of the time, and not mahogany, teak, rosewood, and other tropical species harder than oak. Moreover, they cut the trees in the cool bracing autumn or in winter when a man wants to work fast in order to keep warm. Think how different it would have been if they had had to cut oak trees on the muggiest kind of hot summer days. When the trees have been felled the difficulties of the would-be farmer in the equatorial rainforest have only begun. On our farms at home it is hard work to keep down the weeds, but suppose that the weeds grew a foot or two a month, and kept on growing twelve months in the year. How could anyone keep them down! The useful plants would be choked almost before they sprouted from the seeds. That is what happens in the equatorial rainforest. Unless the inhabitants possess a vigor far surpassing that of the best farmers of the temperate zone, successful agriculture on any large scale is impossible. Even when the white man with the energy, skill, and tools of the North attempts to raise bananas and cacao on the edges of the rainforest, he finds the task very difficult.

Natives and White Men in the Equatorial Rainforest. We are inclined to look down upon the almost naked Papuans of New Guinea, Pygmies

of Central Africa, and aboriginal Indians of the Amazon Basin. We wonder at people who still live by hunting with poisoned arrows, gathering wild fruits and nuts, and perhaps planting a little manioc in some chance opening of the forest. We pity them because they make their homes in little huts in the trees or on poles, because they run away and hide at the sight of a stranger, and because they have nothing that can be called civilization. We ought rather to admire them for having learned so well how to use their difficult environment. Even with all our opportunities, we have not yet learned how to cultivate the lands in the equatorial forest, maintain good roads, and avoid the enervating effect upon health and character. We do these things, indeed, in the Panama Canal Zone, but there many people are gathered in a small space, vast sums of money are available, everyone is under government orders, and no attempt is made at general agriculture except where the rainforest begins to break down. Only the northern end of the Canal Zone is in the rainforest. The rest, where most of the people live, is in a less rainy region of jungle and grass, and that is very different from the ordinary forest region.

Vegetation grows so rapidly in regions of equatorial rainforests that they might be among the most productive parts of the whole world, if only men knew how to improve their poor leached soils and cultivate them. As yet, however, we obtain from them only wild rubber, chewing gum, mahogany, and other forest products. The natives are employed by the white man to search for the trees from which these products are derived, but such work does not advance civilization. In temperate regions trees of one kind often cover many square miles, but within the tropics a great variety of species usually grow together. So the natives wander through the forest, climbing tall trees sometimes to look out over the top of the forests and pick out specimens of the species they are seeking. Then they tap the rubber trees and collect the sap, or call the axeman to chop down a fine rosewood tree. Their overseers are often brutal white men who have come to the tropics simply to get rich. Unchecked by the restrictions of civilization such men use the most outrageous means to gain wealth or to compel the natives to do what they wish. Disappointment and ill health make them more and more brutal, so that they often treat the natives most cruelly. Altogether the natives are by no means improved by their work for the white man. They merely get a pittance which they spend for drink or for useless finery. They are isolated not only from the rest of the world, but even from one another, for their mode of life permits only the scantiest population. In spite of our twentieth century progress the equatorial rainforest still remains almost the worst environment for man.

B. Tropical Scrub Forests and Savannas

An Unfavorable Contrast of Seasons

Look again at Plate II and estimate the size of the Wet and Dry Low Latitudes (No. 3) in comparison with the United States or Europe. India, Australia, and especially South America and Africa have among them millions of square miles of tropical scrub forest and savanna. This kind of vegetation prevails because the dry season is too long and too warm to permit the growth of the larger, denser types of forest. Jungle prevails, to be sure, in a transition zone between the rainforest and the scrub forest, for there the dry season is long enough to make agriculture feasible without introducing difficulties because of prolonged drought. For the present, however, we will pass this by in order to study the less favorable areas where the dry season is too long.

Scrub and Savanna South of the Sahara. Try once more to picture these parts of the world to yourself. As we pass northward from the populous jungle region of Uganda, let us say, in Central Africa, the trees gradually become smaller and stand farther apart, while grass as big as reeds becomes more and more dominant. After a while we find ourselves in a region which would look somewhat like a peach orchard if the grass were smaller. The trees, however, are often umbrella-shaped, thorny, and covered with more or less furry little leaves. Many are acacias. Sometimes they disappear completely, leaving a tract of pure grass. Such a place is generally one where the water drains away rapidly because of sandy soil or because of an elevation slightly higher than that of the surrounding plain. On the other hand, each stream is usually bordered by a band of dense jungle, where one can travel miles without seeing the scrub forest or the savanna. But let the traveler get up in an airplane, and he will discover that the jungle is merely a narrow band, a "gallery forest" skirting the river.

An airplane flight above the scrub forest and savanna is much more impressive in the dry than in the wet season. In the wet season the whole country is beautifully green. From aloft it looks as if it were superbly fertile, except that villages and other signs of people are scarce. In the dry season, on the contrary, most of the land is brown and barren looking. Vast tracks are black, and on their edge smoke is rising in great billows from raging fires that rush through the huge dry grasses so fast that a man on foot can scarcely escape. The natives burn the grass to make the new shoots accessible to their cattle. Mixed with the black and the brown are spots of vivid green. Some very small ones are merely single

trees; larger spots are patches of a few acres, or even a few square miles, where underground water enables trees to thrive in spite of the dry seasons. The narrow green bands of the gallery forests wander here and there like the veins in a leaf. Fly far enough north, and even these green bits disappear, for the savanna has come to an end. Its place is taken by a pure grassland. Finally even the grasses disappear, and one finds himself flying over the yellow sands or gray gravels of the desert.

Animals by the Million

Again and again in such a flight one is likely to see great herds of grass-eating animals. Some are thin, long-horned cattle kept by wandering nomads such as the Shilluks and Dinkas of the Nile Valley, or the Arab tribes who live farther north near the borders of the desert. Many, however, are wild animals. They are most numerous in the better-watered parts of the savanna because that is where the grasses grow in greatest profusion and to greatest size. There one may see herds containing a hundred, a thousand, even ten thousand antelopes of various kinds from little ones smaller than goats up to the big kudu as large as cattle. Even the little ones jump high over the huge grasses when frightened. Mixed with the antelopes, as we have seen, there may be zebras and ostriches, and even giraffes in the sections where there are many trees. Elephants, too, frequent this same type of country. They like to browse upon trees, but not the big trees of the rainforest, or even of the jungle. All these grass-eating animals are found in greatest numbers where grass is abundant and large. The big ones, such as the giraffe, elephant, and rhinoceros, like to live where there are trees for shade and food, but they want the trees to be small enough so that they can reach them, and far enough apart so that grass grows between them and there is room to run when necessary.

Where grass-eating animals are abundant flesh-eating carnivores are also sure to be abundant. If you would see the lion, tiger, leopard, jaguar, hyena, and other fierce beasts, go to the scrub forest and savanna, or perhaps to the more open, grassy parts of the jungle. The tales that you read about hunting zebras and lions from automobiles are in themselves enough to make it clear that this sport belongs to the savannas, not the rainforests. Think, too, of the pictures that you have seen of elephants, lions, and rhinos. The animals are mostly in the grass, or if they are among trees, it is among the low trees of the savanna, or merely in the gallery forest along the streams. Such forests are a great place of refuge for the animals of the savanna. They are good hiding places for the tiger or leopard because all the animals of the grassy plain and hills round about must come to the rivers for water in the dry season.

Travel in Scrub and Savanna

If you leave your airplane and travel on the ground in the scrub forests and savannas, you will soon find that roads are very scarce in most sections. Except in India and on the more favorable edges of the other areas you will find few people and those few will be so poor and backward that they will have practically no roads. You can travel on foot with native carriers; you can use cattle as beasts of burden; you may be able to use horses, but that will be rare because of the coarseness of the grass and the presence of stinging insects and even of the deadly tsetse fly. Or perhaps you can use some kind of motor vehicle, provided you stick to the grassy parts, watch for hidden holes, and have plenty of spare parts, spare time, and patience. Whichever method of travel you choose, you are likely to wish you had come at some other season. In the wet season the rain falls in heavy showers each afternoon, and there is deep, sticky mud everywhere. Unbridged streams pour down in floods where there are hills, or wander aimlessly in deep channels on the plains. In the flat areas, which abound in the savanna sections of the African Sudan and the South American llanos and Gran Chaco, large tracts are often flooded with water so that they temporarily become lakes or ponds, shallow to be sure, but hard to cross because their bottoms consist of deep mud.

If you visit the scrub forests and especially the flat savannas in the dry season, your troubles will be of a different kind. The difficulty will be to find water, not to avoid it. These regions, be it remembered, are among the hottest in the world, much hotter than the rainforest, because for months they are exposed to the unclouded sun. Maxima of a hundred degrees or more are common day after day. Even in the cooler season, a place such as Khartum, 15° north of the equator, has an average temperature of 70° in January, and an average daily maximum not far from 80°. In May, before the summer rains begin, the average for day and night has risen to 91°, and the average maximum to well above 100°. Under such conditions water completely disappears except in the main rivers. Wells dry up unless they are very deep, a hundred feet or more, or are located in low depressions. Well digging in such regions is no light matter. Nine times out of ten in some sections the water of such deep wells is more or less salty.

One of the authors of this book obtained his most vivid realization of the difficulties of travel in the scrub forest and savanna of low latitudes when he contemplated landing at Cape York, the northeastern tip of Australia close to Thursday Island where liners bound for eastern Australia usually make a brief call. He saw the brown hills of the mainland and the clouds of smoke rising from grass fires, but long before that he had given up his plan. He had found that he would have to

bring with him practically every kind of equipment, that it would take weeks to find men who could serve as guides, and that it would take many more weeks of slow dry travel to cover a distance that an airplane could cover in three or four hours.

The People of Tropical Scrub and Savanna

How about the people of these hot low latitudes with their great heat, severe dry seasons, and very wet seasons? How does a climate which produces scrub forest and savanna influence them? The first part of the answer may be found by comparing Plate II with A144, which shows the world's population by means of dots. In Australia and South America the parts of the world included in No. 3 of Plate II are almost free from dots. This is partly because those continents are still new so far as European races are concerned, and are not yet fully populated. The main reason for the scarcity of dots, however, is that in those regions it is so hard to get a living, and life is so unpleasant, that people have not wanted to settle there. The scanty population consists of a few Australian "Black Fellows" and wild Indians, together with a few people of European origin who run cattle ranches. No other occupation is feasible on any large scale. In fact, it is very hard to make a living with cattle. Nomads such as those in the Sudan and clear across Africa south of the Sahara can live contentedly on milk, together with millet and occasional meat from their cattle. They sow the millet when the first rains come. Then they go away with their flocks, perhaps leaving a few old people to protect the millet from thieving birds, beasts, and men. White men are not content with such a standard of living. They need money with which to buy other kinds of food, clothing, and all sorts of equipment and furnishings.

For several reasons it is difficult to get ready money on a cattle ranch in the scrub forest or the tropical savanna. (1) The climate is such that European cattle do not thrive. Even if they can be kept alive, they do not become fat, nor do they give much milk. (2) Other kinds of cattle, such as the Indian zebu, are by no means so good for meat as European cattle raised in cooler regions, and they, too, give little milk. (3) Insects bother the cattle a great deal. Even if the cattle escape the fevers which are brought by the fat, disgusting white insects known as ticks, they are almost sure to be bitten by other insects and to suffer from sores. These not only prevent the animals from getting fat but also leave the hides full of holes, which much diminish their value. (4) Even if the cattle ranchers can raise fairly good beef and hides, they have difficulty in marketing them. This is partly because they have to compete with regions such as Argentina, Uruguay, southern Australia, New Zealand, Ireland,

and our western plains where much better animals can be produced more cheaply. It is also because the transportation facilities are poor. There is no special difficulty about establishing steamship lines in these regions, or even about building railroads or motor roads. The trouble is that the volume of products available for export is too small, and the quality too poor, to make it pay to invest money in means of transportation.

Of course it is possible to raise some crops during the wet season even in the savanna, but the difficulties are great. One difficulty is that export crops, such as are raised on tropical plantations, cannot be raised here nearly so well as in the jungle regions where there is only a short dry season. Even if products of good quality could be raised by irrigation, the cost would be greater than in regions where no irrigation is needed. Then, too, the rains are very unreliable in these wet and dry low latitudes. Nearer the equator there are, of course, years that are unusually dry and others that are too wet for crops, but crop failures due to these causes are rare. Where the dry season is long, however, the danger of complete failure because of drought becomes far greater. Moreover, the opposite danger also increases. When the rains do come, they often fall in such abundance that the soil is washed away and crops are almost drowned. When one adds to this the great heat before the rains arrive and the intensely sticky, muggy weather which prevails during the rainy season, it is not strange that the scrub forests and savannas of Australia and South America are very sparsely populated, while those of Africa are largely left to primitive cattle herders.

Better Parts of the Scrub Forest

Turn once more to Plate II and A225. Examine the density of population in the Wet and Dry Low Latitudes of Africa and India. In both places, but especially in India, the population is less dense than in neighboring regions where Wet Tropical Agriculture prevails, but more dense than in the Australian and South American Wet and Dry Low Latitudes. In Africa this is largely due to the fact that the southern half of the continent is high. This makes the climate cooler and thus diminishes the severity of the dry season. It also gives rise to many mountains and slopes on which there is sufficient rainfall so that the dry season is by no means so severe as in corresponding latitudes on the lowlands north of the equator, or in the other southern continents.

In India a similar condition prevails, but other factors help to increase the density of population. On a relief map note that the whole area where scrub forests and savannas prevail from well down in the south to Rajputana in the north is comparatively high. In the Deccan Plateau the altitude is great enough to lower the temperature appreciably. A more

important factor, however, is ruggedness. The hilliness of the country makes it possible to build a vast number of "tanks" or small ponds. A simple dam of earth is thrown across a small valley in the dry season, and a runway is prepared to carry off the extra water. When the rains come in the summer a pond is formed, and when it is filled the extra water runs off without spoiling the dam. As soon as the ground begins to get dry after the rainy season is over, the water is led to the fields, a little at a time as long as it lasts. This makes it possible for the Indian peasants to depend fully on crops for a living. The tanks are not an unmixed blessing, for they are great places for mosquitoes. India suffers terribly from malaria.

Another reason why regions of the scrub forest and savanna type have a denser population in India than elsewhere is the monsoon winds, which will be discussed in a later chapter. These, together with the presence of the ocean on both sides of the Indian Peninsula, make the rainfall more reliable and more prolonged than in the other areas. Moreover, a large part of the Deccan Plateau has an unusually good volcanic soil. It is called "cotton soil" because a good deal of rather short cotton is raised in it.

The other crops of this part of India include some rice. As a rule, however, there is not enough water for rice, and that crop is raised mainly in the coastal regions and the lower Ganges Valley where the natural vegetation is of the jungle type. The people in the drier parts have to rely largely on a poorer kind of food in the form of "jowar" and other millets. Many chick peas are also raised, together with some corn in the south and wheat in the north. If the rain comes at the right time, these crops grow fairly well, but when it is unduly delayed, or insufficient, terrible famines occur. The total amount produced by each family is surprisingly small. Often it is scarcely more than enough to keep people alive, even in ordinary years, with practically nothing to sell. Hence it is not strange that the village people live in little huts thatched with grass, dress in a single sheet of cheap cotton cloth which lasts a long time, and make their own pottery, baskets, and even cloth. Nevertheless, they are able to maintain a higher type of civilization than the aborigines of Australia, the Indians of South America, and the cattle people of Africa in similar climates. They even have several good-sized cities such as Hyderabad, Poona, Delhi, and Lahore.

QUESTIONS, EXERCISES, AND PROBLEMS

1. (*a*) Write an advertisement for a land company with large holdings in (1) the llanos or savanna of Venezuela, and (2) the equatorial rainforest there. Let every statement be absolutely true, but emphasize the advantages. Would rice (A390) figure in your advertisement? Explain.

(*b*) Write a criticism of your own advertisement, pointing out the disadvantages a settler would find in taking up land, clearing it, building a house and barn, and raising crops and animals and getting them to market. Show in what respects a settler from Wisconsin or from your own state would be especially annoyed by his own ignorance or by his inability to get the kind of labor, transportation, food, and other necessities that he is used to.

2. Look up in the *National Geographic Magazine* or elsewhere an account of the struggle to render the Pañama Zone healthful. Write a short résumé of this health campaign in its relation to geographical conditions.

3. In Brazil the number of immigrants arriving one year was as follows: Portuguese, 28,000; Spaniards, 19,000; Italians, 16,000; Japanese, 4,000; Poles, 3,000; Syrians, 3,000; Austro-Hungarians, 1,000; French, 700; English, 500. As a rule, however, the Italians now outnumber the others, while Germans are quite numerous. Determine which of these settlers would find it easiest to adapt themselves to (*a*) the coffee regions; (*b*) the drier grassy regions of the interior; (*c*) the Amazon valley. Consider this question from the point of view of (1) health; (2) agriculture; (3) customary methods of house building; (4) use of animals.

CHAPTER XIX

THE BETTER TROPICAL REGIONS

The Tropical Jungle

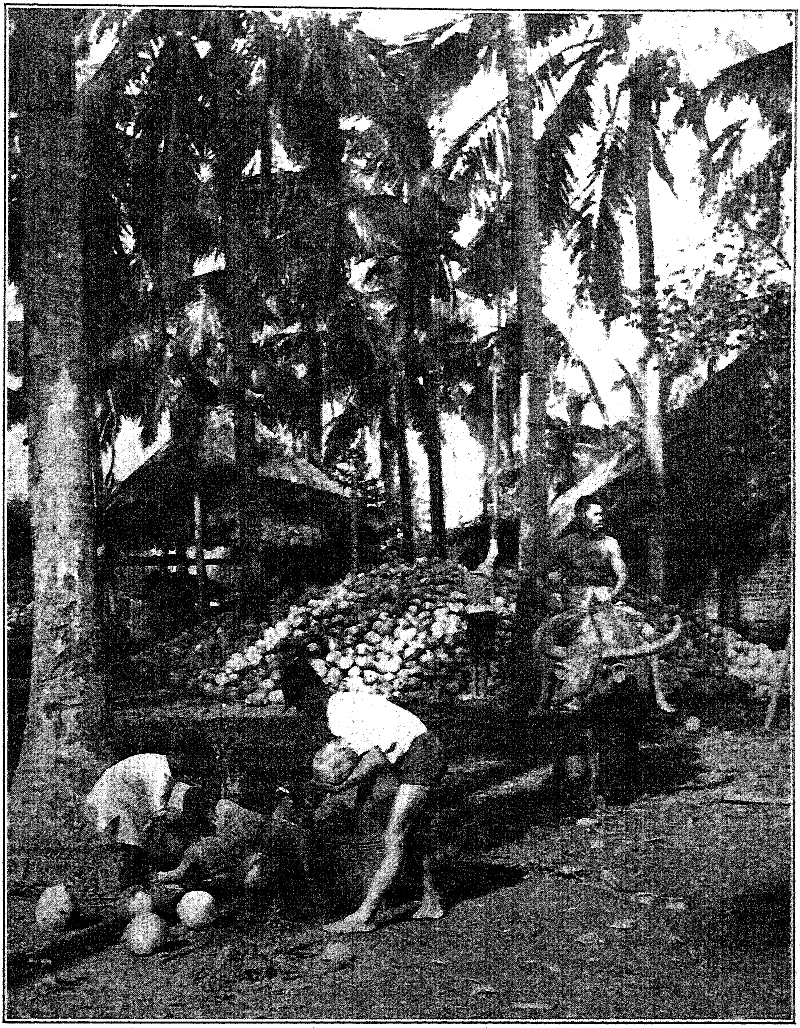
The difference between tropical regions which are constantly wet and those where there is a short dry season is amazing. It becomes still more astonishing when it is combined with the contrast between poor leached lateritic soils and the good soil of alluvial plains, young coastal plains, or mountain slopes, especially if they are volcanic. As one passes from the equatorial regions of greatest and steadiest rainfall, the size of the trees and the density of their stand diminish. Because of a more pronounced dry season, or better drainage, tropical jungle, the second heading in the table of A361, takes the place of the dripping rainforest, and the conditions of life correspondingly improve. This does not mean that the vegetation is small or scanty. Large trees still grow in abundance, but among such kinds as mahogany, teak, rosewood, and logwood one finds also a bewildering variety of palms, bamboos, tree ferns, banana-like plants, and many other huge-leaved types. For miles the tangle of vegetation is often so dense that one can penetrate it only by cutting a path through the living wall. Now and then a group of chattering monkeys goes swinging through the treetops, parrots with harsh voices call attention to their own beautiful colors, and the jaunty crow of the jungle cock reminds one of the barnyard.

On the drier edge of the jungle, where grass begins to be abundant, an elephant is occasionally seen browsing on the bushes, deer jump through the openings, wild pigs, dogs, and rodents scamper through the brush, while tigers, leopards, and other beasts of prey lie in wait on low branches or prowl in secret paths hidden from the sight of man.

Ease of Jungle Life

In regions where tropical jungle still prevails in its natural state, the people get a living with little effort, provided the population is not dense. The coconut and banana furnish food with only a little work, the big fruit of the papaw supplies a family with a meal for the plucking. Wild rice in Siam, yams in Central Africa, the edible seeds of the bamboo in southern India, can often be gathered with ease. Elsewhere the bread-

fruit tree, the sago palm, the sugar palm, the jack-fruit tree, and many other food-producing plants need only be planted and protected in order



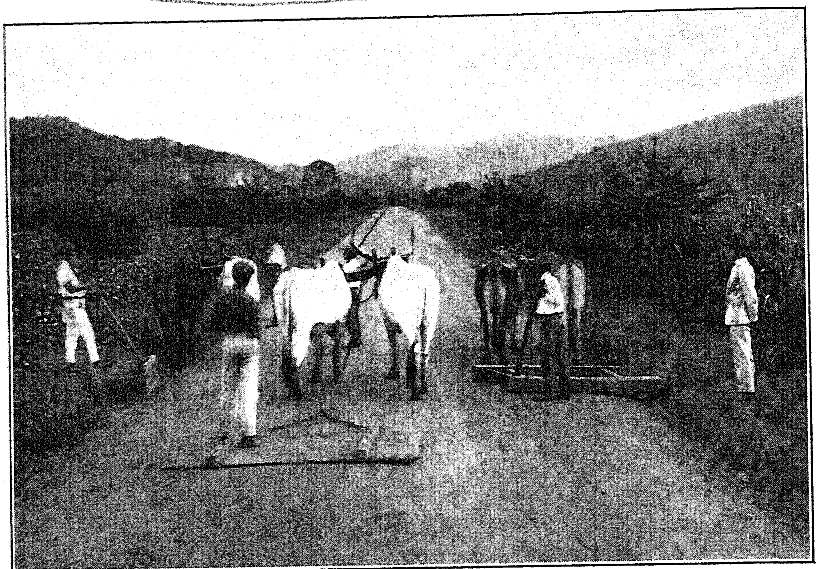
Keystone View Co.

A—Gathering Coconuts to Make Copra in the Philippines.

Note (1) water buffalo with widely spreading horns, (2) house with thatched roof and latticed walls of bamboo, (3) detached cooking shed with mud oven.

to furnish abundant food. Life is relatively easy, and the natives have little to spur them to effort. Clothing is a luxury, not a necessity; houses need to be little more than a thatch of palm leaves set on a rude frame

of poles; wood for building and cooking can be picked up almost anywhere. Under such conditions, so long as the population remains scanty, we should not expect much progress in the well-watered jungle regions. Southern India, Ceylon, Indo-China, the East Indies, Central America, and large areas on the borders of the dense rainforest in Africa and South America are examples of this type, although in many places the population is so dense that the difficulty of getting a living has increased a good deal. Such reclaimed regions of wet tropical agriculture are the home of the majority of tropical people. In spite of their relatively small



Courtesy of P. H. Rolfe.

A—The Use of Tropical Cattle—Roadmaking in Southern Brazil on the Plateau.

A clay road is being smoothed with homemade, wooden implements pulled by oxen, which do most of the farm work and hauling.

size, they support far more people than do the tropical rainforest, scrub lands, and grasslands.

The Character of Wet Tropical Agriculture

The More Primitive Types. The lowest and easiest type of agriculture is found in the sparsely settled parts of the tropical jungle. It consists mainly of planting a few palm trees, banana plants, and other fruit trees. After that, as is jokingly said, the native has nothing to do except lie under the trees and wait for the fruit to drop into his mouth. Nevertheless, some manioc, yams, corn, or sweet potatoes are also raised by the

women in patches so weedy that one scarcely recognizes them. Such agriculture, if we may call it by that name, is a step toward civilization, but only a slight one, for it does not stimulate the natives to steady work.

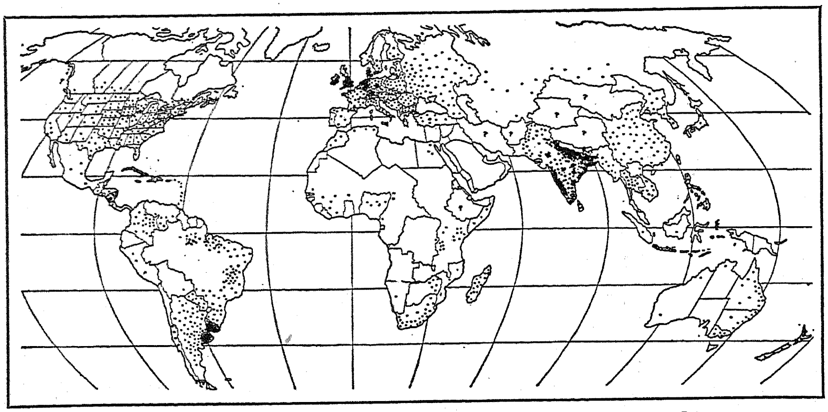
In the more densely populated tropical countries a somewhat higher type of agriculture prevails. The bushes and smaller trees of the jungle are hacked down and the larger trees are killed by cutting off a girdle of bark. At the end of the dry season the brush is dry enough to burn. Then the primitive farmer goes over the burned field with a pointed stick making holes into which seeds are dropped. A little rough weeding is done until the young plants are large enough to take care of themselves. No other work is required until harvest time. The easiest food to raise is such starchy tubers as yams and sweet potatoes, or such starchy roots as the cassava or manioc from which our tapioca is made. Several soft varieties of Indian corn, the common pumpkin, and various kinds of beans furnish a supply of food more healthful and more easily preserved than the roots. They also require more careful planning and more work, and thus have a correspondingly greater effect in promoting industry. A still greater effect of this kind is produced in the large sections where agriculture centers around rice farming. This is so important that it is discussed separately below.

Difficulties of the Tropical Farmer. (1) RAPID EXHAUSTION OF SOIL. Agriculture in tropical countries is more difficult than in the temperate zone. In the first place, the soil is often so badly leached that it is easily exhausted. It also suffers from the accumulation of bacteria. The rapid exhaustion arises partly because constant heat and moisture cause dead vegetation to disappear so completely and rapidly that the soil contains little humus and hence little nitrogen. Other plant foods are also scarce, for as soon as the soil is decomposed by weathering, the heavy rains leach them out. Thus, although the first crop is often bountiful, later ones diminish rapidly, especially when corn and millet are planted and bacteria become abundant. Hence many jungle farmers clear a new patch of jungle every two or three years, and often every year.

(2) TOUGH GRASSES. In densely populated regions the same land must be used year after year in spite of the scanty crops. Here other troubles arise. For instance, if other weeds are kept down, tropical grasses, like witch-grass but far worse, often overrun the land. In the Philippines "cogon" grass has been the ruin of thousands of farmers who have tried to use fertilizers and otherwise follow modern methods so as to keep the same field in cultivation for a number of years. As the grass often grows as high as a man's head and has correspondingly tough roots, no ordinary animals can drag a plow through it.

(3) SPARSITY AND POOR QUALITY OF DOMESTIC ANIMALS. The difficulties

due to the poor soil and rank grass are increased by the fact that in jungle regions domestic animals generally thrive only a little better than in the equatorial rainforest. In A388, to be sure, India appears to have an immense number of cattle. And so it has, but in proportion to the population they are not so numerous as in the United States. Moreover, they are mainly of different species from our cattle. Humped zebus or Brahman cattle and ugly hairless water buffaloes are the most numerous. There are other types, however, such as the gayal of North India, while Java has many of the bantin species. Most of the cattle of southeastern Asia are of poor quality, undersized, ill fed, and ill cared for. They give so little milk that the British call them "teacup cows." Not only are they unable to plow tough sod, but they supply only a small amount of



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Distribution of Cattle.

manure, especially in the moister regions, where animals are least abundant and fertilizer is most needed. Moreover, because the Hindu religion forbids the killing of cattle, many animals are so old that they are useless. They simply consume forage which might be fed to animals that are of value. In the Wet and Dry sections of India, but not so much in the Regions of Wet Tropical Agriculture, the dung of cattle is often used as fuel or for plastering walls instead of for fertilizer. In moderately dry parts of India animals are so scarce and fertilizer so valuable that people often pay for the privilege of having goats and sheep herded on their fields during the night.

(4) INSECT PESTS. As the climax of his difficulties the tropical farmer has to contend with all manner of insect pests, rusts, blights, and bacterial infections. They are worse than those of the temperate zone almost in

proportion to the greater luxuriance of vegetation. Although the farmer can get a living without much difficulty, he is greatly handicapped when he attempts European methods.

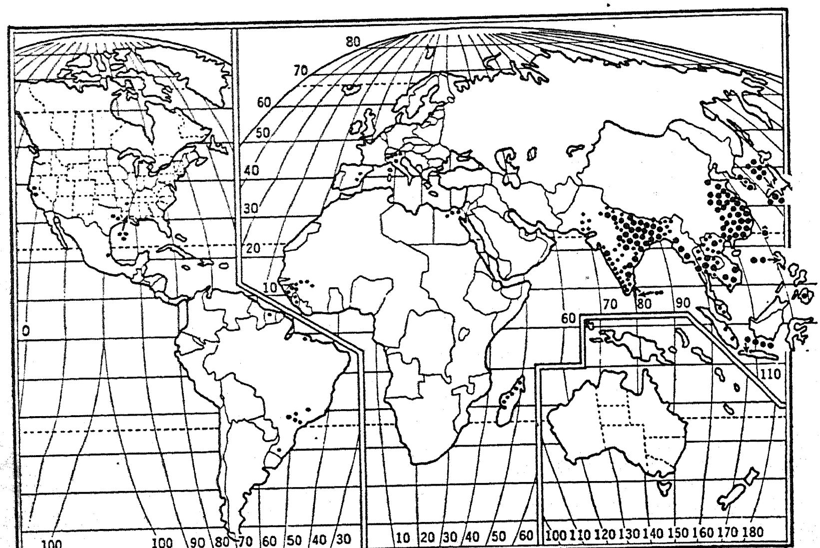
(5) LACK OF ENERGY. To the handicaps of poor soil, tough grass, few and inefficient domestic animals, and insect pests, we must add the lack of energy which is natural in a tropical climate. We must also remember that all these difficulties lead to a very low production of crops per acre. Moreover, the density of population and the low energy of the people restrict the cultivated area to a very few acres per family. Accordingly there is almost no surplus, and the farmers cannot buy tools or make improvements. It is literally true that to many Indian farmers a new hoe or spade means as much as a new automobile to many of our farmers. In view of all this, it is not strange that through long ages the jungle farmer has acquired the habit of not caring whether he makes progress or not. If he thinks about it at all, he simply feels helpless and hopeless. If our acestors had lived for centuries in such a region, we should probably be as inefficient as the people of the tropical jungle.

Rice as an Example

The Careless Farmers of Ceylon. The methods of tropical people are well illustrated by the way in which rice is often raised. When the fields in the jungle districts of Ceylon, for example, have been thoroughly saturated by the first rains of the season, or by water turned on from irrigation ditches, the soil is turned up with a rough spade or wooden plow and then trampled with the feet until it becomes a creamy paste of mud on which the seed is sown broadcast. When the seed has germinated, water is again admitted, and the rice left to grow until harvest time. Then the water is turned off and the crop ripens. The grain is harvested with sickles, and is threshed by being trodden under the feet of bullocks. It is winnowed in an equally primitive fashion by being thrown into the air from flat basketwork trays, and caught again, while the chaff is blown away.

The people who practice this primitive mode of rice culture are astonishingly indolent according to our standards, but not according to theirs. For instance, in 1903 the inhabitants of a certain district in Ceylon raised an unusually large crop of rice. They thereupon sat down to eat it, and many raised not a blade of rice the next year. The third year their seed rice was almost all they had left. This was sown, but the crop was largely destroyed by caterpillars. Then these inefficient people who had not worked for nearly two years appealed to the government to keep them from famine.

The Skillful Rice Farmer. Although such occurrences are typical of some tropical people, they become less common where more careful methods of rice culture are employed. Such methods are employed among many tropical people even in countries such as Ceylon and Java close to the equator. The methods of the hundreds of millions of people who depend on rice farther north in countries such as Thailand (Siam) and Burma are better than in Java, while in China and Japan there is still more improvement. Even in Thailand and Burma, which are genuinely tropical, the rice seed is sown in prepared beds. Then after five or six weeks it is painstakingly transplanted to the fields which have been carefully

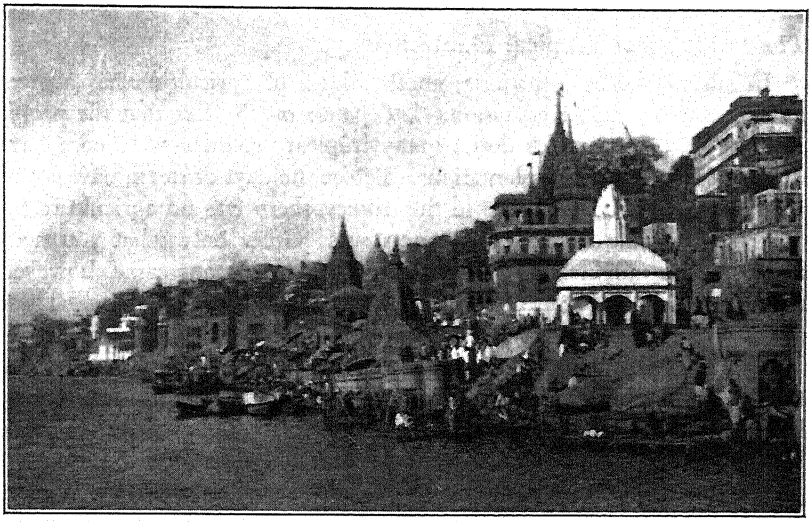


A—World Production of Rice. Large dots one per cent and small dots one-tenth of one per cent of world production.

plowed and manured. The rice fields are surrounded by mud embankments so constructed that water can be held there week after week, not standing perfectly still, but gently moving. The beds are occasionally weeded with care, and finally the crop is harvested promptly so that the ripe grain may not fall out and be lost. Under good conditions 50 pounds of rice will furnish seed for an acre of transplanted rice, and the yield will be 2,500 pounds, or fiftyfold. This amount, when combined with some beans or meat to furnish protein, is a year's ample food for five adults. Thus a population of 2,000 per square mile is possible. On this basis all the people in the United States could be supported on an area equal to New York State. The yield of rice in low latitudes, however,

is much less than this. Within 10° of the equator, for example, the average yield per acre is only 40 per cent as much as in latitudes 30–40°.

How the Best Rice Farming Promotes Civilization. Rice culture is a distinct help in promoting civilization. For one thing, a rice farmer can profitably keep cattle. Notice how cattle and rice show a similar distribution in India in A388 and A390. Even though the animals are small, they can plow the soft soil of the weedless rice fields. They also help the farmers to use the same fields permanently, for they supply manure, and thus the soil does not become exhausted. They can be fed on rice straw when the fields are flooded and grass is lacking. Rice straw,



Courtesy of B. M. DeCon.

A—The Sacred Ganges at Benares. A great city has grown up here in response to the needs of pilgrims.

to be sure, is poor forage, but grass grows rapidly along the edges of the ditches and in the rice fields when they are fallow. A still greater help in preserving the fertility of rice fields is that they are generally irrigated with muddy water from hills or mountains. The mud settles on the fields and provides fresh soil which has not yet been badly leached.

In the next place, since the enrichment of the soil enables the farmer to devote his energies to one particular piece of land he is likely to improve his rice fields and to take care that he has a good supply of water and that all his little ditches and dikes are in good order. He finds that the work of one year gives him much benefit the next. Moreover, he cannot go off and leave the rice crop untended, for a few weeks of carelessness

will ruin it. All these conditions cause the careful rice-raising people of India, Java, Indo-China, and especially Siam and Burma to be more industrious and reliable than other tropical farmers. For the same reasons they are more progressive, since the best of them can produce a small surplus which can be used for tools, clothing, ornaments, and education. Moreover, as the rice-raising population is much denser than elsewhere, roads and schools can be maintained, and the people can get more stimulus and help from one another and from outsiders.

Possibilities of Plantation Agriculture

The Products of Tropical Plantations

In addition to rice farming, another kind of agriculture has a great influence on tropical civilization. It depends on the fact that the people of more bracing climates desire many tropical products and hence have established thousands of plantations. Before the days of steam navigation, when Europeans rarely came to the tropics, there was no agriculture for export. The rule of tropical farmers was "Grow only what you need and consume only what you grow." When Europeans came, however, they began to want tea, coffee, cocoa, rubber, and other products. These at first were luxuries, but fast became necessities.

As a rule plantation products are not like the staple food crops which have to be planted each year. They are tree crops which do not require frequent renewal. They are raised in large plantations where the same kind of tree or bush is planted over wide areas. Coffee is a good example. Although small quantities are raised in regions such as Java, Ceylon, Central America, and Mocha, where coffee first became known, nearly two thirds of the world's supply comes from Brazil. There hundreds of thousands of acres of tropical jungle have been cleared of most of the trees, and coffee bushes have been planted in the shade of the rest. Tea flourishes under similar conditions, although it grows over a wider range of latitude than coffee. It is raised in great plantations on moist sunny slopes, chiefly in Ceylon and among the mountains of Assam at the base of the Himalayas north of Calcutta, but also in southern China, Java, and Japan.

Cool Tropical Highlands

What has just been said about tea and coffee suggests one of the reasons why many people fail to realize how many kinds of tropical regions there are. They fail to separate lowlands from highlands. Each of the places mentioned in the last paragraph is either a cool tropical high-

land, of the kind shown in Plate II, or else has many mountains whose slopes at altitudes of a few thousand feet are relatively cool and pleasant. Little coffee is grown at altitudes of less than 2,000 feet. This is true even in Brazil, where the great coffee region is as far from the equator as New York is from Havana. The Brazilian coffee comes mainly from the southeastern plateau back of Rio de Janeiro. There São Paulo, on the plateau at an altitude well above 2,000 feet, is one of the most progressive of tropical cities. Its seaport at Santos, 50 miles away, does a surprisingly large amount of shipping for a place of its size. To get there one drives down a road that has to wind and twist delightfully in order to reach the face of the steep escarpment that drops sharply from the plateau to a mere strip of young coastal plain. Or perhaps one winds still more on a railroad which once was one of the richest in the world because it made so much money carrying coffee. Nearer the equator, in regions such as Colombia, British Guiana, Ceylon, and Kenya in Central Africa, coffee is raised at higher altitudes than in southern Brazil. It thrives best where it experiences temperatures averaging at least as low as 60° for day and night together.

Tea grows best with a temperature lower than the optimum for coffee. One can be sure of this from the fact that it is one of the great crops not only in southern China, but also as far north as southern Japan. There it grows near sealevel. It cannot be raised at any great altitude because it would be killed by frost. Nevertheless, it grows best in climates where the weather sometimes is almost cold enough for frost. Accordingly in tropical latitudes the tea plantations of regions such as Ceylon are located high on mountain sides or plateaus.

Quinine, the great remedy for malaria, is another tropical plantation product which grows in the cool plateaus or among the mountains. It was formerly derived from the bark of the wild cinchona tree, which is a native of the Andes in Peru. There it has ceased to be of importance as a wild product and is not raised on plantations. Java now supplies practically the whole of the world's quinine. There it is raised at high levels, sometimes a mile above the sea. The Dutch government has established an excellent experiment station where new varieties of cinchona are developed, new types of legumes are raised in order to give nitrates to the soil, and other experiments are carried on. Few places are more delightful than such a plantation on a cool morning. The air has the freshness of spring; the roadsides are gay with tropical flowers such as the many-hued lantana with its balls of red and yellow; graceful Javanese women pass by carrying baskets full of tea leaves on their heads; and one looks away across a deep valley to blue mountains where the smoke is rising from a volcano.

Because of the relatively cool climate tropical highlands are the home of a more active and progressive population than is found in the lowlands. Venezuela, Colombia, Ecuador, and Bolivia all have their capitals and their main population at levels of anywhere between 3,000 and 12,000 feet above the sea. The largest of all cities in the cool tropical highlands is Mexico City over 7,000 feet above the sea. Guatemala, Salvador, Honduras, and Costa Rica are like Mexico in having their capitals and main population at a considerable altitude above the sea. The Costa Rican plateau is one of the few parts of Central America where there is a considerable white population unmixed with either Indians or Negroes. In the Old World, Ethiopia, because it is a high plateau with relatively energetic people, and with the protection of mountains, remained independent long after the rest of Africa had fallen into the hands of Europeans. Uganda in Central Africa, a mile above the sea, had the most advanced people of tropical Africa and the best-organized government before the coming of the white man. Kenya, not far away and even higher, is the only part of tropical Africa where the white man has established himself as a permanent settler.

The crops in the cool tropical highlands are a good deal like those of higher latitudes. Rice, tea, and coffee, to be sure, are important, but so are corn, wheat, and potatoes, provided one goes high enough. Potatoes, for example, apparently first came from an altitude somewhere above 6,000 feet in Peru. Corn is a staple crop throughout the Andean and Brazilian highlands. In Kenya a white variety with very large soft kernels yields big crops. The only trouble is that it is so soft that it does not keep well, and the distance to markets is prohibitively great. This illustrates one reason why cool tropical highlands, in spite of their many favorable conditions, do not play much part in the world's trade and commerce. Most of them suffer from difficult transportation and consequent isolation.

Plantations in Tropical Lowlands

Let us return now to the lowland regions of wet tropical agriculture. In some of them Europeans and Americans have established large plantations for the cultivation of the cacao tree, from whose seeds chocolate and cocoa are made. Much cocoa comes from tropical Africa, particularly the Gold Coast and Nigeria. Brazil, the West Indies, and Venezuela come next in importance. At one time Ecuador rivaled Brazil for second place next to the Gold Coast as a producer of cacao, but a blight has caused the trees to die in great numbers. Such disasters appear to be more common and destructive in low latitudes than in those where cool winters prevail.

Although bananas can be grown in the same regions as tea and coffee,

they belong primarily to the lower, warmer, and moister parts of the jungle on the borders of the equatorial rainforest. Thus they are like cacao in being more of a lowland and forest crop than are tea and coffee. In Central America, the West Indies, and the northern part of South America great corporations from the United States have cleared thousands of acres of jungle and planted them with this easily raised fruit. One great company employs many thousand men and has regular lines of steamships to bring bananas and other tropical fruits to New Orleans, Baltimore, Philadelphia, New York, and Boston. The fruit comes from Honduras, Costa Rica, Panama, Colombia, and practically every other Caribbean country and large island.

Rubber is raised in somewhat the same way as bananas. The principal plantations are in the Malay Peninsula, Sumatra, and neighboring islands including Ceylon. A small and diminishing fraction of the world's supply still comes from the wild trees of the forests of Central and South America, but the plantation is of constantly increasing importance.

Still other tropical plants such as the manila hemp of the Philippines—the best of fibers for strong twine and rope—have their home in the jungle, but are gradually being raised more and more exclusively in plantations. The same is true of indigo, which is still raised in large quantities in India and Java in spite of the great use of aniline dyes made from coal tar.

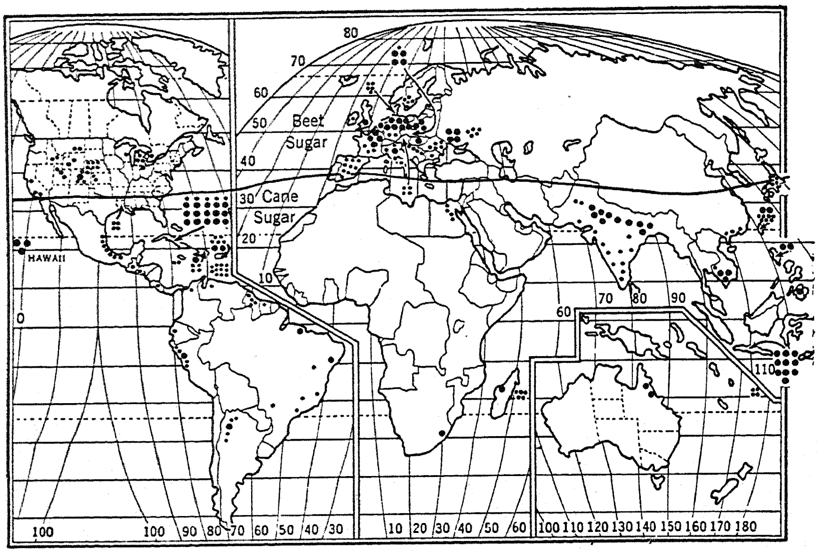
The sweet bark of the cinnamon tree, raised especially in Ceylon, is another sample of the many tropical products which are increasingly used by Europeans and Americans, and which lend themselves to plantation agriculture.

Sugar as an Illustration of a Plantation Product

Its Importance. The most important plantation crop is sugar. Two hundred years ago, the average person in England consumed less than 4 pounds of sugar per year, and the average American still less. Before the first World War the average English consumption was almost 100 pounds, and the American over 80. Today sugar has become such an important food that the average English-speaking person consumes a third as much of it as of wheat. Ordinarily people do not realize the importance of the sugar supply, but during both world wars almost everyone realized it. In New York in 1918 a temporary shortage actually led to riots in which mobs broke into stores that were supposed to have a supply. For many months no one was permitted to buy more than a pound or two at a time, and the names of the buyers were carefully recorded so that no one might get more than his share.

Sugar from Tropical versus Temperate Regions. About three-fifths of the world's sugar comes normally from tropical countries. A century ago the whole supply came from there. The tropical sugar is made from the sugar-cane, a plant from 8 to 15 feet tall and resembling a cornstalk without ears. The rest is made from beets and comes from the countries in the zone of cyclonic storms, such as Germany, France, old Czechoslovakia and Poland, western Russia, and the United States.

Sugar is one of the few products in which temperate and tropical regions compete. The tropical regions have a great advantage because they possess enormous areas fit for sugar and as yet little used. More-



A—World Production of Sugar. Large dots one per cent, small dots one-tenth of one per cent, of world production.

over, the sugar-cane is naturally able to yield much more sugar per acre than are beets. The temperate regions, on the other hand, have the great advantage of being located close to the chief markets, so that their sugar saves freight charges. They are also close to a supply of labor that is vastly more efficient than that of the tropics. Because of these conditions the beet itself and also the methods of extracting its sugar in the sugar factories have been so much improved that whereas 18 pounds of beets were needed to make 1 pound of sugar in 1836, only a third as many are now needed. The improvement of the sugar-cane, on the other hand, did not begin so soon. Like many other tropical products,

the cane is good in its unimproved state and the backward people of the tropics have taken little thought to make it better. Now, however, the people of the temperate zone are taking charge of sugar production, and during the last few decades, in places such as Hawaii and Java, there has been rapid progress toward as great an improvement in the cane as has taken place in the beet.

How Sugar Is Raised in the Tropics. Sugar is so useful and so easily extracted from the sap that great quantities of cane are raised in little patches in most tropical regions, especially where there is plenty of sun as well as water. This home-made sugar, however, rarely reaches the world markets. Their supply comes from big plantations. Cuba is the chief source of the American supply, but almost every tropical country makes some sugar. Most of the plantations are near the seacoast, largely because the coastal regions are not only more accessible than the interior, but are more likely to have the kind of warm, damp plains and fertile soil which the sugar-cane loves. Often, too, the immediate coast is more healthful than the hot, steamy plains a few miles inland. This is particularly true in countries such as British Guiana, where the climate is admirable for sugar, but bad for people. The native labor there is so inefficient and unreliable that it has been necessary to import laborers from the East Indies and India. The contrast between the native and imported labor is a good example of the way in which rice-raising people reach much higher levels of civilization than do people whose agriculture has scarcely risen above the point of growing yams.

Many of the sugar plantations, not merely in Guiana, but in most sugar regions, are of large size and in the past have been highly profitable. In Cuba, whence the United States gets most of its cane sugar, some plantations employ as many as 5,000 people, and have scores of miles of little portable railways which can be laid wherever they are wanted to bring the cane from the fields. In the Hawaiian Islands, the absence of any duty on sugar imported into the United States has helped to make sugar the dominant product. In good years profits of three or four hundred dollars per acre have been realized, although of late the industry has had a great many troubles because too many plantations were established. Nevertheless, the industry has been so profitable that it has been worth while to go to great expense for irrigation. Water has been pumped in some places to a level several hundred feet above its source, and in others, tunnels have been built through mountains to bring the water from the windward side, where it is deposited by the northeast trades, to the dry, sunny leeward side where the cane grows fastest provided it is well watered.

Governments and Sugar

Sugar affords an interesting example of the way in which governments alter the location of human activities. Up to about 1930 Java was one of the world's chief sources of sugar. The crop was profitable to the Dutch, who supplied the necessary capital and sent out managers and technical men, and to the Javanese, who worked in the fields and the mills. Then came the great financial depression which began in 1929. In all the advanced countries people had less money than before and soon tens of millions were out of work. Almost everyone had to economize, and one of the easiest ways to do so was to cut out candy and other sweets. This reduced the demand for sugar and lowered prices. Then various governments began to do something to help their own sugar raisers. The United States raised its tariff on sugar, and then established quotas. The quotas meant that Louisiana could raise a certain amount, the beet-sugar people of the United States their special amount, and the same for Hawaii, Puerto Rico, and the Philippines. After our own sugar raisers had thus been taken care of as well as possible, Cuba was given a preferential tariff—a lower rate than other nations—so that it could sell its sugar to us at rates which other producers could not afford.

At the same time Germany, France, Great Britain, and many other European countries gave their own beet-sugar raisers special advantages, either by clapping on tariffs against other nations or by paying bounties according to the amount of sugar beets raised by the farmers. Another new factor was that the government of India helped British and Indian capitalists to establish a great number of modern sugar mills in that country, whose vast population makes it one of the big sugar users. The result was that poor Java could find no place in which to sell most of its sugar. The sugar industry fell all to pieces and became insignificant compared with what it used to be. Such changes in the geographical distribution of human activities often occur because of new inventions and discoveries, as well as because of the action of governments. Cuba has suffered greatly because of low prices for sugar, but not so much as Java.

How Plantations Promote Civilization

Plantation agriculture is beginning to have an important effect upon tropical civilization. In places where there are no plantations, white adventurers still send the natives out into the jungle to gather wild cacoa, wild cinchona, wild rubber, and even wild hemp and wild bananas. The natives live as they have always lived. If they have enough to eat, they stay at home no matter how eager the white man may be to complete

a load for his vessel. If one day's work gives food enough for three days, they work only a third of the time, no matter how much the white man complains. If they contract malaria or other diseases in the jungle, they die without care or medicine.

On the plantations these things are beginning to be changed. The plantations are usually owned and managed by Europeans or Americans who have a permanent interest in them. On the best and most profitable plantations the employees are obliged to live in better houses, and take more care of health and sanitation than tropical people ever thought of before. Drains are dug, stagnant pools are filled, and other measures are taken to get rid of mosquitoes and other disease-bearing insects. Machinery is introduced, and the natives are taught to use it. At first they are rarely competent for any but the simplest tasks. Little by little, however, they acquire skill and industry. Preference is given to those who work regularly, keep their huts neat, obey the health regulations, and show evidence of willingness and ability to learn the complicated methods of the white man. The incentives to progress include the desire to imitate the white man as well as to purchase some of the luxuries displayed in the company stores.

On the plantations, health is considered of great importance. Hospitals are provided not only for the white man, but also for the natives. Where the government does not support them, as in Ceylon, they are often run by private companies, as a matter of economy. The largest fruit company in tropical America regularly deducts 2 per cent from the wages of its employees from the highest to the lowest, and uses the money as a fund to protect the general health. Thus the strength of the natives is not sapped by disease so much as formerly, and they are better able and more willing to do hard work.

As the plantations increase in number, the population grows more dense. In Java, for instance, they have taken up a considerable part of the more rugged southern areas which formerly contained few people. Thus while the plantations provide the opportunity for steady work, they also make it less easy for people to get a living from wild fruits, nuts, and game, or even by the cruder forms of tropical agriculture. It therefore becomes more necessary than before to settle down to steady work, and of course it is also more profitable to do this now than formerly. It is still difficult, to be sure, to find tropical people who will work except when compelled to do so by hunger, but the standards of life are beginning to rise. This is bound to happen more and more, for the limited parts of the tropical zone where wet tropical agriculture is possible offer one of the largest and richest of all fields for the investment of capital and brains.

Plantations and Population in Java

In spite of the recent collapse of the sugar industry in Java the presence of the Dutch there has had a remarkable effect on the growth of population and industry. The Dutch went there because they wanted to buy spices and other tropical products and ship them to the Netherlands. They soon began to raise sugar and other plantation crops. In order to be successful in their efforts, it was necessary to establish peace and encourage good government. Many mistakes were made at first, but the Dutch gradually learned that their own profits increased in proportion to the health and prosperity of the Javanese people. So better laws were

Weissenborn, Garoet, Java.

A—Javanese Women Manufacturing Pottery.

Note the varied designs, some quite beautiful.

framed, and in due time the government improved the roads of the island, built railroads, and tried to put an end to malaria and other diseases. At the same time the Dutch provided increasing opportunities for steady work to a degree scarcely equaled in any other tropical regions unless it be in such places as Barbadoes, Jamaica, and Hawaii. The experience of the Dutch in Java was one of the important factors in teaching Americans how to do a good job in the Philippines.

One of the most astonishing results of the Dutch occupation of their East Indian colonies had been an enormous increase in population. Since about 1820, without any immigration worth mentioning, the population of Java has increased almost ninefold, from 5 million well toward 45

million. In the rich plains of volcanic soil on the north side of the island, where the dry season is of just the right length, large areas support from 1,000 to 2,000 people per square mile. This is even more than the dense population of manufacturing countries such as Belgium and England. Iowa is about one tenth larger than Java, but has only 1 inhabitant for every 16 in Java. Such an increase in population can occur only in rare places where climate, soil, and human actions all combine to produce a similar result.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Which of the elements of geographic environment (A4) first led Europeans to explore the tropics? Which elements now furnish motives to the greater part of the Americans and Europeans who go to the tropics? Explain in detail the geographical conditions which make it far more necessary for Americans and Europeans to keep in touch with their old homes when in the tropics than when they go to places such as New Zealand and Siberia? Why is it more necessary for Europeans to keep in touch with the tropics than for the people of the United States?

2. In the *Statesman's Yearbook* or elsewhere look up the exports of a tropical land mentioned in this chapter. Classify the exports under the following heads: (*a*) products of wild vegetation; (*b*) products of plantation agriculture; (*c*) non-vegetable products. What geographical reasons can you see why one or another of these types of products should come from each specific country?

3. Examine the areas covered by the colonial empires of England, France, and Russia. Classify these lands according to the vegetation zones in which they lie.

4. In the government reports on Foreign Commerce and Navigation, and in the *Statistical Abstract of the United States*, look up six plantation products from tropical countries. Which of these come from the types of regions discussed in this chapter? Make a table as follows and arrange the products in order according to the increase in their per capita use:

A	B	C
Product	Percentage of increase in imports, during 20 years	Chief countries of origin

CHAPTER XX

MODES OF LIFE IN DESERTS AND POLAR REGIONS

Two Kinds of Deserts

Between latitudes 20° and 30° on the west side of every continent intensely dry deserts border the ocean. Most of them lie on the polar side of savannas. The Andes, however, alter this arrangement in South America, and the Arabian Sea and its branches prevent Asia from having savannas west of India. Plate II shows that these tradewind deserts, as they may properly be called, stretch eastward from western Africa across the Sahara, Arabia, Iraq, and southern Persia to Baluchistan and the Indus Valley in India. They also include northwestern Mexico, northern Chile, the Kalahari region of southern Africa, and a large part of the west and south of Australia. They are all alike in having the following characteristics: (1) slight rainfall; (2) scanty vegetation; (3) practically no agriculture; (4) dependence of man on animals; (5) a sparse and often nomadic population; and (6) low civilization.

If we examine the whole world we find that certain other regions also have these six qualities. These other regions are of two types, (1) continental deserts and (2) polar regions. The continental deserts are in most respects like the tradewind deserts. The chief difference is that, although most of the year they are hot like the tradewind deserts, they have a period when they are cold like the polar deserts. Nevada and Utah are mild examples of this kind, as is the desert of Patagonia, east of the Andes. The deserts of Central Asia from the Caspian Sea to the borders of Manchuria are extreme examples. The polar regions, which have the six characteristics named above, are not deserts in the ordinary sense, for they are covered with snow much of the time and the ground is moist if this melts. Yet in their effect on man the cold regions of Greenland, the northern parts of North America and Asia, the vast continent of Antarctica, and many limited regions at high altitudes such as the higher parts of Tibet are much like deserts. Hence in this chapter we shall discuss these cold, wet polar deserts after finishing the ordinary hot, dry deserts.

Sparsity of Desert Population

The sparsity of desert population is astonishing. For instance, the desert part of Arabia, omitting the fairly well-watered regions of Yemen and Oman, is as large as the United States east of the Mississippi River. Yet its population is probably less than 2 million, whereas the corresponding portion of the United States has 70 million. In southern Arabia the 300,000 square miles of absolute desert that were never crossed by Europeans until 1931 contain no permanent inhabitants, and most parts are never visited even by the Beduin who live around the border. This area equals that of Germany and Italy, combined, which contain over 100 million people. The great Sahara, which is as large as the United States, probably has less people than the Arabian Desert, and the Australian Desert has least of all among the dry deserts. In our own country, Nevada has only one person for each square mile, and most of these are gathered in oases such as Reno at the eastern base of the Sierras. Contrast this with Massachusetts, which has over 500 people per square mile.

Cold deserts have even fewer people than dry deserts. For instance, if we omit mineral districts such as the Yukon mining district, the Mackenzie oilfields, and the regions near Great Bear Lake to which men go in airplanes in search of radium, an area of 2 million square miles, northern Canada has only about 20,000 inhabitants. This part of Canada is as large as all Europe aside from Russia, but it has only 1 inhabitant where the European countries have 16,500. Antarctica, the greatest of all deserts, has not a single inhabitant.

The Physical Character of Deserts

Their Appearance. Dry deserts present a peculiar appearance. Parts consist of mountains and parts of plains. Among mountains the bare rock everywhere sticks out, often painting the landscape with weird colors. Sometimes it is shattered and broken by the action of frost and sun. Elsewhere it is roughly pitted by the wind. Only in the higher parts of the mountains is the climate moist enough so that there is a fairly deep cover of soil held in place by vegetation.

The weathered rock and soil from the mountains are washed down to the lowlands by the occasional violent rains which fall even in deserts. At the base of the mountains the wet weather torrents deposit their load in great tracts of sloping gravel like enormous beaches from 1 to 40 miles wide. Close to the mountains the gravel consists of large rough fragments, but farther away the materials become more pebbly and sandy. Finally they merge into plains of sand and clay. Often the sand

is heaped into dunes, while the clay is scoured by the wind into fantastic pillars and tables.

If the mountains furnish water enough the lowest part of each plain contains either a salt lake or a "dry lake," known as a playa. Such a lake at most times presents the appearance of an absolutely flat expanse of smooth clay, but after one of the occasional rains it is transformed into a lake in which the water may be only a few inches deep.

In the well-populated parts of the world vegetation is so abundant that it hides the soil; in deserts the vegetation is so scanty that the traveler
2 is constantly reminded of the rock and soil. What little vegetation he sees, however, is peculiarly interesting, as we saw in Chapter XVII, because of the strange forms which it has acquired in its attempt to meet the conditions of drought.

Sandy Deserts. Although sandy deserts do not occupy any larger area than those of bare rock, gravel, and clay, they present the most
3 unusual appearance, largely because of the presence of dunes of every size. That is why the most familiar pictures of deserts show sandy dunes. In the Takla Makan Desert of western China millions of sand dunes of many tones of yellow, brown, and pink look like the waves of a huge dry sea 600 miles long. Only the boldest explorers dare launch their caravans on such a waterless sea. The wind piles the dunes up to a height of 500 feet and thus causes them to be an almost impassable barrier. Even when the dunes are small the feet of men and animals
a sink into the unstable sand and slip and slide so that progress is extremely slow. Often it is impossible to climb the steep leeward slope of a dune, although the gentler windward slope may be comparatively easy. When violent winds blow the sharp sand with cutting force into the traveler's face there is nothing to do but turn one's back to the wind and try to escape suffocation. The camel has become so well adapted to this condition of desert life that he is able to close his nostrils and open them only at long intervals for a quick breath.

4 *How Loess Is Formed and Used.* When the wind blows over the desert it not only heaps the particles of sand into dunes, but carries away the finer dust and deposits it in the form of *loess*. From the Takla Makan and Gobi deserts the dust is sometimes blown in such quantities that 60 or 100 miles to the southeast it makes the air so hazy that the sun is hidden even at noon. Beyond the limits of the deserts it falls as a fine yellow powder. It even sifts into the tightly closed houses and makes it difficult to write by coating the paper and clogging the pen. In northwestern China this desert dust has accumulated in some places to a depth of scores or hundreds of feet over an area larger than France. It is very fertile if it is well supplied with water. Where

there is no vegetation to hold it, however, it is so light that it is quickly blown away. Along the roads in the loess country the dust is stirred up by the feet of horses and then blown away so that the roads become deep trenches. In spite of its lightness the loess does not easily crumble. Its thick, fine-grained masses can be cut like cheese. It sticks together so well that houses can be excavated in it. Near the borders of the deserts in northwestern China many peasants live in such houses dug in the walls of the sunken streets.

Why Desert Lakes Are Salt. Aside from the dunes and the vegetation one of the most striking features of the desert is the lakes. Occasionally they are beautiful, but oftener they have flat muddy shores crusted with white crystals, looking somewhat like tide flats and smelling far worse. Desert lakes generally have no outlets and hence are salty. 5 This is because both in deserts and elsewhere every stream contains a little dissolved salt, although ordinarily this cannot be detected except by chemical analysis. In desert lakes, as in the ocean, evaporation removes the water without removing the salt, which in ordinary lakes would escape with the water through the outlet. Hence all the salt that is brought in by the streams remains in the lake, finally forming a strong brine so heavy that the bather finds himself lifted from the bottom when he walks out as far as his armpits. Woe betide him, in the Dead Sea, for example, if he gets the stinging brine into his eyes or nose. The Dead Sea is well named, for there is practically no life in it. a Great Salt Lake in Utah is similar to the Dead Sea, but not quite so saline and far shallower. Many great salt lakes have dried up, leaving their salt in solid layers, scores b or hundreds of feet thick. In Central Asia such salt deposits cover thousands of square miles. In Germany, as we have seen, far older ones, deeply buried beneath later rocks, furnish supplies of potash and other valuable minerals. In New York and Michigan similar old deposits are mined for common salt.

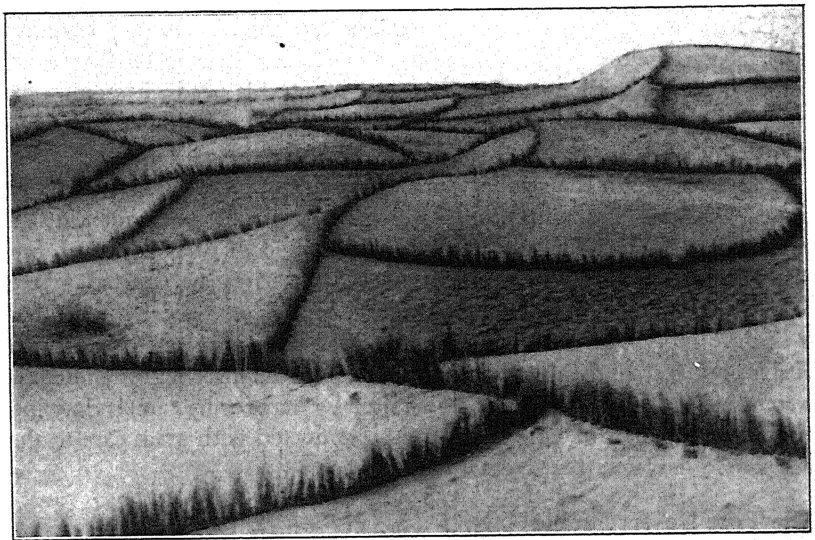
Desert Vegetation

The vegetation of deserts varies from region to region as much as does that of the forests. For example, on the borders of the Transcaspian Desert beyond the Caspian Sea and in parts of the Arabian Desert the whole country seems to consist of nothing but bare sand dunes. Then comes a heavy rain, and within a week or two the sand is covered with \ a short, sweet growth of grass which makes it look as fertile as the prairie. Yet in a few more weeks the grass has ripened its seeds and dried up, and soon the sand is blowing as freely as before. Farther out in the desert there is very rarely any growth of grass, but the sand is dotted here and there with tough little bushes 3 or 4 feet high which seem

leafless until one notices the little scales pressed tight against the stems. In some of the greatest deserts where sand dunes rise to heights of several hundred feet the space between the dunes is gouged out by the wind 2 to such a depth that the water table is almost reached. Here one sometimes finds beds of reeds or patches of the feathery shrub called tamarisk. As the dunes slowly advance they may kill such plants, but sometimes, if the dunes are small, the plants may shoot up fast enough to keep their heads above the sand. Occasionally, after the dunes have gone on and again left them uncovered, one finds reeds and bushes curiously elongated as if on stilts.

In deserts where the ground consists of gravel the vegetation is even less abundant than in sandy deserts for there are few favored low spots, and even when rain comes, the plants have hard work to grow. In many deserts where gravel prevails the finer materials have been swept away by the wind, leaving a surface composed almost wholly of pebbles. As the sand is swept across these by the wind it smooths and polishes the upper 3 side. In due time the desert heat turns the surface of most rocks black. Hence many deserts contain tracts of "desert pavement," that is, a mosaic of smoothed pebbles coated with dark "desert varnish." In some of the vaster deserts of Persia and Central Asia the gravel at the foot of the mountains forms desert pavements like huge beaches 10, 20, or even 40 miles wide. In many places where there is no pavement, the upper surface of the desert soil is cemented into a solid, slightly salty, calcareous whitish cake. This is because the rainwater does not escape from such 4 regions by flowing away underground, but by evaporation. After the infrequent rains the water may penetrate the soil to a depth of 2 or 3 feet, but later, as the soil becomes dry, the water rises again to the surface by means of what is called osmosis. Meanwhile, however, it has dissolved some lime and other salts, and these it leaves in the upper part of the soil to form "hardpan" or caliche, as the calcareous layer is called. Sometimes, when the hardpan dries after having been soaked by one of the occasional rains, it splits into irregular polygons 5 to 12 feet in diameter, between which are cracks several inches deep. In these the wind deposits sand, and then tiny plants take root. Thus the polygons are sometimes outlined in green, like little gardens where the plants occupy the paths instead of the beds. In deserts where gravel is mixed with soil an unusual 5 rain may sometimes cause the desert to blossom as the rose. One would have to travel far to find any scene more beautiful than the Mohave Desert of California, or than inner Australia, at such a time. The ground is carpeted for miles with the loveliest flowers, white, yellow, orange, and blue. People who are not familiar with deserts often think that such a region is actually fertile enough for crops.

In deserts such as most of those in the United States, where some rain falls in both summer and winter, bushy vegetation is the predominant type. The newcomer who sees the abundant sage brush of Utah and Nevada, or the larger greasewood and mesquite of Arizona with the accompanying cactus and the grasses that spring up after rains, can scarcely believe that in a region which looks so fertile agriculture is impossible. Many a tenderfoot from the East has thought to his cost that the westerners were lying when they told him not to take up land of that kind. He found, however, that the types of vegetation which grow



Keystone View Co.

A—Harnessing the Desert. Here in Libya the Italians are trying to prevent the sand dunes from blowing onto the cultivated land by planting grasses that can grow with a minimum of water.

in the desert can subsist on an amount of moisture which cannot possibly support crops. That is the great outstanding feature of every desert.

Oases

The spots called oases are places where desert vegetation gives place to that of well-watered regions. Although they are in the desert, they are not of it. Yet they must be considered, since they occur in every desert, and support far more people than the vast surrounding areas. Moreover, the true desert people, the nomads, have much the same relation to the oases that country people have to cities. The larger oases are places where streams from the mountains spread out upon the desert plain and serve

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b for irrigation. The mountains and the oases may be as far apart as the snowy heights of the Himalayas and the hot sunny delta of the Indus. The whole of cultivated Egypt indeed, with its 14 million people, is a great oasis watered by the rains that fall on the mountains of Central Africa. In such oases millet, corn, wheat, barley, grapes, and many other c crops and fruits are raised. The houses are generally made of sun-dried bricks called adobe. Sometimes, where there are trees enough, the houses have wooden frames, but in the oases of the driest deserts such as eastern Persia even the roofs are made of adobe bricks forming the kind of small domes seen near Aleppo. In books we hear much of the beauty of the oasis of Damascus, for example, but generally the descriptions are exaggerated. Nevertheless, when a traveler on a camel, the ship of the desert, comes to an oasis where he can rest and supply his needs, it seems very beautiful to him just as any port seems a haven of rest to a storm-tossed mariner.

Palm Oases. In the smaller oases of the driest, hottest deserts, such as those of Arabia and northern Africa, palm trees are the main kind of vegetation. We are likely to think that this kind of oasis is typical, but really it is comparatively unimportant. Such oases are located where d little springs bubble out of the earth or in depressions where the ground is slightly moist and wells can be dug. The palms are often planted in pits 5 or 6 feet deep where the soil is moist. At much greater depths water can be obtained in wells. It is raised by hand or by camels drawing buckets at the ends of long ropes and is conducted with great care to the pits where it waters the trees.

The True Desert People

The Nomadic Mode of Life. Outside the oases the only thing upon 1 which desert people can rely for a living is animals. Sheep, goats, donkeys, a and especially camels can live on the scanty vegetation of almost all deserts, but they must constantly be kept moving from one pasturage to 2 another. Hence the desert people are nomadic. Their success depends upon their ability to find for their flocks sufficient vegetation and water. Accordingly, it is not surprising that when one meets a Beduin Arab in the Syrian Desert, for example, he at once asks, "Has rain fallen anywhere?" If the traveler reports showers along his route, the Arab hastens back to camp, announces the good news to his family and gives orders to prepare to move. Next morning the tents are taken down, the household goods are gathered up and, with the children, are put on the backs of camels. In an hour, the trampled ground and the blackened stones where the fire of camel dung has gone out are the only signs of the encampment.

It must not be thought that the Arab rashly moves his camp with-
out knowing where he can get water. He is familiar with all the water
holes, springs, and wells, and has special places to which he regularly 3
migrates provided there is grass. Sometimes, to be sure, if the rain
is especially abundant and the grass grows thick and green, as occurs
at long intervals, he does not need to camp beside a source of drinking
water. The animals eat so much green grass that they can get along
without water, and the people make milk serve for both food and drink.
As for washing it is enough for the Arab to rub his hands in the sand.
In spite of the fact that the Mohammedan religion especially commands
"the faithful" to wash their hands and feet before each of the five
daily prayers, the Koran expressly says that where no water is available,
sand may be used instead. Millions of Arabs have perhaps lived and
died without ever taking a real bath.

The Property of Desert Nomads. Among desert nomads little, 4 1
aside from animals, can really be called wealth. Some, to be sure,
have larger herds and flocks and better guns, clothing, and tents than
their comrades, but none live in houses or have elaborate furniture.
If a man tried to have such things he could not reach fresh pastures
and new springs in time to keep his animals in good condition. More-
over, life is so hard that there is little chance to accumulate the surplus
that would buy these things. Among the Arabs, for example, poverty
is so nearly universal that there are few differences such as exist where 2
some people live in great palaces and others in tenements of one or two
rooms, and where some perform hard, ill-paid manual labor, while others
live in ease upon the accumulated wealth of their ancestors.

The chief thing that keeps the Arabs poor is that the rains fail and 3
the grass withers at frequent intervals. Then the animals begin to
suffer from hunger; the mother camels and sheep give no milk, and their
colts and lambs begin to die. Soon the Arabs have neither young animals
to exchange for rice, millet, and dates in the oases, nor milk to keep
themselves from starvation. So long as anyone has food he shares it a
with his neighbors, but all alike suffer greatly. They dare not kill too
many animals, for then they would destroy their sole means of support. 4

How Poverty Leads to Desert Raids. The hardships of the desert
cause the nomad's ideas of right and wrong to differ from ours. What
is an Arab to do when his camels, his sheep, his wife, his children, and
himself are all suffering the pangs of hunger? The only thing that 4 1
occurs to him is to plunder. Hence he goes on raids. A raid is an inter-
esting event. A group of Arabs are sitting on the ground in a circle
at sunset. Suddenly one of them rises and thrusts his spear into the
ground. "I am going on a raid," he says. "Who will go with me?"

One by one the others quietly but vigorously drive their spears into the sand as a sign that they too will go. Early the next morning a dozen or twenty keen-eyed Arabs ride off across the desert on their camels. A few are leading horses for the final swift dash. On long raids only those horses can be used that have been taught to drink camel's milk. After riding one or two hundred miles the raiders discover a nomad camp which they plan to plunder. Waiting until nightfall the horsemen silently and swiftly drive off the camels which are herded not far from the tents. If necessary the raiders shoot the camel-keeper, but they try to avoid such extreme measures, for if one member of a family or clan is killed, the rest are never satisfied until they take a life for a life.

How Raids Influence Arab Character. We believe that a man should treat his neighbors as he would wish to be treated himself, but through thousands of years the hard conditions imposed by the desert climate have weeded out the Arabs who are not ready for violence. To succeed in the desert a man must be ready not only to engage in plundering expeditions, but likewise to endure heat, thirst, and the weariness of long rides. Unfortunately, however, he has little need of steady industry. When he comes home from a raid or from an exhausting hunt for stray animals, he is so tired that he lies down and does nothing for days. If he is able to summon up his powers when his camels are driven off, or his sheep have strayed, his laziness does little harm. The ordinary work of caring for the animals is so light that the women and children can easily do it and still have plenty of time to rest. Hence the Arab is not only dishonest, according to our standards, but also lazy. He thinks of raids as a part of the ordinary routine of life, and of steady work as something fit only for slaves.

How Nomads Are Governed. Nomads who live in tents and go on raids are almost invariably a source of trouble to an ordinary government, for not only are they lawless raiders, but they bitterly resent any outside interference. As the camps are small and widely scattered it is extremely difficult to punish evil doers. Hence patriarchal government, or the "rule of the father," still persists. Each camp generally consists of relatives. The father sets up his tent surrounded by the families of his sons and nephews, and often of his grandsons. His word is law. Where several families live together the power is given to a sheikh. Sometimes the office of sheikh passes from father to son, but only when the son's character justifies his authority in the eyes of the clan. Otherwise, the sheikh is elected because of his wisdom, courage, and liberality.

Good Qualities in the Desert. The desert promotes good qualities as well as bad. The traveler is struck by the proud and manly bearing of the bronzed Beduin. Although fierce and reckless when pushed by

necessity, they are faithful unto death when once they have given their a
word. Hospitality, too, is a universal trait. As the nomad travels about b
the desert in search of stray animals or on his way to an oasis to buy dates or sell animals he would often suffer severely or even perish if the occasional people whose tents he passes were not willing to entertain him. Even in the tents of his enemies a man finds food and shelter and can remain safely from the evening of one day till the morning of the second day after. So strong is the sense of hospitality that an Arab will make a feast for a guest even if he and his family are obliged to go hungry.

The nomads of the desert are also very brave and daring. c
"What do you do if a young man proves to be a coward when he goes on his first raid?" said one of the authors of this book to a white-haired Sudani chief with a long white beard. "That is a very bad thing," said the old man, shaking his head. "We warn him, reason with him, and give him another chance. But if he goes on being a coward, we drive him out. His wife, if he has one, drives him from the tent. No parents will give a daughter to him in marriage. Even his mother disowns him. He must leave the free people of the desert, and join the slaves in the oases. Have I known such cases? Indeed I have." Thus we see that the desert people have been made brave not only by the teaching of their elders, but likewise by biological selection. For hundreds and thousands of years the cowards have been weeded out, so that only brave men are the fathers d
of the next generation. Selection of another sort has weeded out the nomadic families in which alertness and the power of quick decision and leadership were lacking. A nomadic group that lacks these qualities is likely to starve because it cannot find its animals when they are stampeded, or recover them when they are driven away by hostile raiders. Hence such families tend to die out or else move to the oases. Thus we see that the deserts influence not only racial character but biological inheritance as e
well. The same is true of other environments, although the evidence is not so clear.

The Frozen Deserts of the North

In cold deserts the nomads depend partly on land animals and partly 1
on those of the sea. Among the Lapps who live in the tundra the reindeer takes the place of the camel. 2
Unlike the Arabs, however, the Lapps are not great raiders. 3
This is partly because famine does not beset them so sorely as it does the Arabs, and partly because they cannot travel so 4
easily.

The Eskimos who depend on sea animals ~~have a harder time than~~ the reindeer people. In extremely cold countries not only is the vegetation of the sea more abundant than that of the land, but also the amount

of small floating animal life is more than in any other part of the ocean, because it does not decay so quickly. Hence along the northern coasts of Asia and America the sea is inhabited by seals and fish which furnish food for polar bears, wolves, foxes, gulls, and other sea birds. All these animals can be used by man for food. The land furnishes much less food than the sea, for although large herds of muskoxen and caribou are sometimes found, they are rare, and have never been domesticated. Unfortunately the sea animals cannot be domesticated. The seals, fish, bears, and gulls come and go as they choose, and the Eskimos, Aleuts, and other coast nomads who depend on them must follow as best they can.

During the summer the nomads live in tents—crude little shelters made of skins and supported in the center on sticks of precious driftwood or large bones like the ribs of whales. The Eskimos have even less furniture than the Arabs, and their tents are less pretentious. In winter such tents are too cold, for the thermometer remains far below zero for months during the long, depressing arctic night. At that season little hunting can be done, and so far as possible the Eskimos must live on meat that they have stored during the summer. Therefore, having moved to the most southern part of the region which they frequent, they shelter themselves in huts of stone, sod, and skins. Sometimes, however, they are obliged to migrate in search of food even in winter. Then at each camping place they build houses of blocks of snow, with sheets of ice for windows.

The only domestic animal that the Eskimo keeps is the dog, which draws his sledge and helps him in his hunting. The dog can easily be kept by hunters and fishermen such as the Eskimos because he eats flesh, whereas other domestic animals, except the comparatively useless cat, live almost wholly on grass, grain, or other vegetable products. Since most of the animals that are hunted by the Eskimos live in the water, boats are of far more importance than dogs as means of transportation. They are constructed with the greatest skill from skins, bones, and driftwood. Few races are more clever than the Eskimo in making the most of scanty resources.

The Eskimos are as notable for their peaceable character as the Arabs for raids. This does not mean that the Eskimos have higher standards of right and wrong than the Arabs, or that they have greater prosperity. They steal from outsiders when they get a chance, and are so poverty-stricken most of the time that they would doubtless plunder if they could. They refrain from raids simply because raids do not pay. The next encampment may be 100 miles away, for along the whole northern coast of America and part of Asia the Eskimos number only about 30,000. No one has flocks, herds, or much other wealth that is worth plundering,

or that can easily be carried or driven away. Moreover, the chances are nine out of ten that at times when one community is suffering from hunger, their neighbors, even though far distant, are also suffering.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Trace from a map of the United States the boundaries of Arizona, Kansas, and Pennsylvania, putting the three in a row. Insert one dot for each 100,000 inhabitants. Make a table showing the comparative conditions of the three states in the following respects: (*a*) latitude; (*b*) altitude; (*c*) distance from the ocean; (*d*) mean temperature; (*e*) total rainfall; (*f*) season of most rainfall; (*g*) type of vegetation; (*h*) mode of life; (*i*) main industries; (*j*) population; (*k*) density of population. Point out the effect of (*a*) to (*f*), respectively, on each of the conditions (*g*) to (*k*).

2. Write an account of the Egyptian peasants in contrast with the nomads of Arabia. Give statistics as to rainfall, temperature, and density of population for each country. Describe main resources, method of utilizing the resources, types of dwellings, government in its relation to environment, and any other topics that interest you.

3. Look up the article on the *Mohammedan religion* in the Encyclopædia Britannica, or elsewhere, and find what are sometimes called the "Ten Commandments" of the religion. How many deal with habits and customs arising out of conditions of nomadic life? Explain.

4. Read some account of arctic or antarctic exploration (Peary, Scott, Shackleton, Stefansson, Byrd, etc., will do; Mrs. Peary's account of housekeeping, etc., in Greenland is excellent), and then classify the difficulties encountered under the following heads: (*a*) food; (*b*) preparation of a dwelling house; (*c*) clothing; (*d*) transportation and communication; (*e*) effect of climate on health through (1) daily conditions, (2) seasonal conditions.

5. Read some account of desert exploration and treat the matter as in the preceding question.

6. A. In an encyclopedia or general history look up the following subjects: (1) the Huns under Attila and others about A.D. 450; (2) the Arabs who burst out from Arabia about A.D. 650; (3) Genghis Khan, who devastated Asia about A.D. 1200; (4) the Moguls, who swept into India soon after A.D. 1500.

B. What effect do you think that the conditions of life in steppes and deserts have had in giving desert people the qualities which have repeatedly enabled them to establish themselves as the rulers of agricultural peoples?

C. Describe as many ways as possible in which the desert environment reflects itself in the habits and military methods of these conquerors. Some are suggested in the following quotation regarding the Huns: "Trained riders, archers and javelin throwers from infancy, they advanced to the attack in numerous companies of horsemen following hard upon each other, avoiding close quarters, but wearing out their antagonists by the persistency of their onslaughts. Scarce a corner of Europe was safe from them."

D. The four outbursts of desert people mentioned under A all took place during periods when the deserts suffered from unusual aridity. Point out what this may have had to do with the matter.

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CHAPTER XXI

LIFE IN MEDITERRANEAN AND MILD EAST-COAST REGIONS

How East Coasts Differ from West Coasts in Latitudes 20° to 40°

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Nearly half the people of the earth live between latitudes 20° and 40°. In these latitudes each continent shows a strong contrast between a sparsely populated west coast and a densely populated east coast. The sparsity of the population on the west coast is due to the fact that the summers are dry. The subtropical belts of high pressure are partly responsible for the dryness. In summer they often move so far from the equator that even in latitudes as high as 40° they either cause the air to descend, whereby it grows warm and dry, or else give rise to tradewinds. When these winds originate in warm sunny continental areas, as do those starting in any continental area more than a few hundred miles from the east coast, they are relatively hot and dry to begin with. Since they blow toward lower latitudes, they become warmer as they move forward. This makes them absorb moisture instead of giving it up, unless they are forced to rise over mountains. Moreover, in summer, cyclonic storms are almost unknown in latitudes 20° to 40° on the west sides of continents. Thus many circumstances combine to give a dry summer to the center and west side of a continent in these latitudes.

1 a why

b In winter, on the other hand, the subtropical belt of high pressure and the tradewinds which blow out from it swing equatorward. Their place is taken by westerly winds. Thus moisture-laden air is carried from relatively warm oceans to lands that have now become quite cool. This, of course, tends to cause rain. At the same time cyclonic storms move nearer to the equator than in summer, sweeping as far as latitude 30° or lower. This, too, causes rain. Accordingly the west coast of each continent has a region with summer droughts and winter rain, as appears in Plate II. Such regions are sometimes called subtropical because they lie beyond the tropics, but are semi-tropical. A better name is *Mediterranean* because they are especially well developed around the Mediterranean Sea.

c

The corresponding latitudes of the east sides of the continents have a seasonal distribution of rainfall quite different from that of the west

coasts. They everywhere have abundant rain in summer and may also have an abundance in winter. The summer rains of these east-coast regions arise partly from the fact that as the tradewind belt moves farther from the equator its northeasterly winds blow from the ocean to the land. Hence they are laden with moisture, which they are ready to give up as soon as either mountains, cyclonic storms, or any other conditions cause the air to rise. Far more important, however, is the fact that on east coasts in latitudes 20° to 40° there is a tendency toward the development of inblowing *monsoons* in summer and corresponding outblowing winds in winter. The cause of the summer monsoons is the indraft due to the heating of the continents. Monsoon regions where this kind of indraft is strong normally lie directly across the continents from west-coast deserts and regions of the Mediterranean type. In both India and China, and to a smaller degree in the United States, the summer monsoons are more or less southerly winds which blow inland from oceans that are warmed not only by the summer sun, but also by currents of equatorial origin. When the warm, moist tropical air brought by such winds rises because of high land or masses of cooler polar air, it is bound to give up rain.

In winter such monsoon regions are under the influence of cold outblowing winds which are pushed out from the high-pressure areas in the higher latitudes of the continents. This is preeminently true of Asia. Since such outblowing winds are dry and are moving toward warmer region, they do not supply rain and are the cause of very dry winters. Hence at Peiping in North China the months of December, January, and February get a total of only 0.4 inch of precipitation, whereas June, July, and August get 18.7. Even at Hongkong in South China, near the Tropic of Cancer, the contrast between summer and winter is almost equally great, for the corresponding figures are 4.0 and 43.8. In North America, however, the monsoon effect is greatly mitigated by cyclonic storms, which bring relatively warm air from the sea, and give our southeastern states a good rainfall even in winter.

In general, the corresponding parts of all continents have the same kind of climate. This is especially well seen in the similarity of the climate in the west-coast areas where the Mediterranean or subtropical type prevails in all the continents. On the other hand, the uniformity of the climate in corresponding parts of the various continents is much modified by the size, shape, and relief of the lands, and by ocean currents. This is especially evident in the east-coast monsoon climates which are quite different in Asia from what they are in North America. Both of these in turn depart in many ways from the corresponding type in South America and Australia.

Where Subtropical and Monsoon Regions Are Located

In Eurasia the comparatively dry subtropical regions comprise southern Spain and Portugal, southern Italy, Greece, Turkey, and Persia, to which should be added the neighboring parts of North Africa bordering the Mediterranean Sea. These, it will be seen, include practically all the most famous empires of antiquity, such as Rome, Greece, Babylonia, Syria, Egypt, and Carthage. Their total population amounts to about 100 million. The corresponding populous monsoon regions on the east side of Eurasia are far more populous. They embrace much of India, including parts that belong to Wet and Dry Low Latitudes and to Regions of Wet Tropical Agriculture (Plate II). They also include French Indo-China and China Proper. They, too, were the seats of ancient civilizations. Their present population is about 600 million or more.

In South Africa the tapering of the continent brings the subtropical and monsoon regions so close together that both are included in the Union of South Africa. Yet the contrast between the dry subtropical region of the west coast north of Cape Town and the wet monsoon region of the east coast around Durban in Natal is scarcely less than between Greece and China, for example. In Australia the two regions are much farther apart, but the contrast is much the same as in South Africa. Western Australia is so dry that its population is only one in three square miles, while in Queensland and New South Wales on the east the rains are so favorable that the population is twenty times more dense.

In the western hemisphere the dry subtropical regions of northern Chile contrast strongly with the wet monsoon or tradewind region of southern Brazil and Uruguay. In our own country California and Utah share many of the qualities of the Mediterranean subtropical regions, while Georgia and the neighboring states have the monsoon qualities of abundant summer rain and a fairly dense population.

A Visit to a Subtropical Region

Let us compare a typical subtropical and a typical monsoon region and see how they differ. Suppose a friend should ask you about the famous Syrian province of Aleppo and the equally famous Chinese province of Shantung on opposite sides of Asia in latitude 34° to 38° N. Could you tell which has the greater population; which would be a better field for a big irrigation project; or which would offer a better market for reaping-machines, leather, hoes, or cotton cloth? Could you tell in which place one could buy horses, camels, or sheep, or in which new varieties of pigs or watermelons might be found? When you understand the difference between subtropical and monsoon climates, you will easily answer these questions and many others with no help beyond a good map.

Suppose you were to land at Alexandretta in August and proceed inland to Aleppo, the capital of the province of the same name. You could easily hire an automobile for the dusty drive of 60 or 70 miles, but it would be more interesting to travel on horseback along one of the many trails. The mountains, which must first be crossed, are covered with typical subtropical vegetation. Sometimes it is scrubby dry forest. Elsewhere it is grass so dry and barren that you wonder what supports the flocks of sheep that follow the ragged shepherd boys as they pipe on shrill, wooden flutes.

The people live in the valleys. Beside every spring of sufficient size stands a village surrounded by vineyards and by groves of apricot, mulberry, fig, and poplar trees. Aside from a few patches of melons and onions there are few vegetable gardens. Each village, however, possesses broad, unfenced fields of pale yellow stubble where cattle are now browsing. Two months or more ago the grain was cut, and the circular threshing floors of smoothly packed earth were piled with golden wheat and paler straw, or perchance with barley. Then the grain was threshed by the feet of oxen and donkeys driven around and around over the straw. Now some of it is waiting to be carried home, for the Oriental does not hurry. In spite of its long stay in the open air, one sees no evidence that it has been wet by rain.

In the villages the houses are made either of sun-dried adobe bricks or of stones plastered with mud. Some have low pyramidal roofs covered with red tiles, but most of the people can afford only flat earthen roofs, which have to be rolled after every rain to keep them hard. Most of the women, being Mohammedans, still conceal their faces beneath veils, for Syria has not changed so rapidly as Turkey. But when one gets an occasional glimpse of them grinding flour in hand mills, or doing other household tasks, one sees that they put aside their veils when at work. Now that the harvest is over, the men and boys seem to spend much of their time loafing. As the traveler dismounts at some unspoiled mountain village they spread a rug for him under the mulberry trees beside one of the little reservoirs that hold the limited water supply. Then they bring coffee, which came perhaps from Mocha in Arabia, and wheat bread, mutton, melons, grapes, and the sour milk called "leben" or "yowort."

Beyond the mountains a drier climate gives the scene a new aspect. At the eastern base of the mountains on the edge of the great inner plain, each of the larger valleys has a village at its mouth, and fields of dry stubble extend for miles. Here the villages present a most curious appearance. Each room of the one-story houses is surmounted by its own high and almost conical dome of dried mud. The dry summers cause wood

to be so scarce that ordinary persons cannot afford beams to support their roofs. So they build domes of mud, a habit which is common in other dry regions, such as eastern Persia. As the traveler proceeds across the plain, the villages and fields become less and less frequent, until finally he sees a group of low black tents beside a well, with a flock of sheep and a drove of camels not far away. He has reached a region too dry for agriculture, and fit only for desert nomads, who wander with their camels in search of water and pasture.

The Trade That Might Flourish. While riding through this country, the traveler might perhaps say to himself, "Not much chance to sell leather here. From the hides of their numerous animals the people can get all the leather they want, but this might be a good place to buy either undressed hides or wool. Not much market for hoes, either, for there are practically no vegetable gardens and grain does not need hoes; but these people ought to plow their broad fields with something better than wooden plows and reap them with machines instead of hand sickles. How good those melons were! We ought to have that kind at home."

Why Manufacturing Does Not Flourish. Then the traveler might fall to wondering why manufacturing does not thrive when there seems to be so much unemployed labor. During the reaping season, and again in the fall when the seed is sown, the people work willingly but slowly from dawn till dusk, but between the busy seasons they are usually idle. The hot, monotonous summer and the prevalence of malaria sap people's strength. The climate causes the yield of crops to be small. Other conditions, such as long-established customs, also combine to prevent the people from being inventive and ambitious. They cannot save up much capital, and as yet they have done little in the way of building factories.

A Midsummer Visit to a Typical Monsoon Region in Eastern Asia

Transportation. A visit to Shantung at the same season as our Aleppo visit would show a very different scene. Even at the steamer landing in Tsingtau there are few automobiles and not many vehicles drawn by horses. Most of the vehicles are drawn or pushed by men. For passengers there are jinrikishas, like overgrown baby carriages, while for freight and baggage there are wheelbarrows with the wheel in the center halfway from front to back, instead of at the end. In the interior away from the few railroads and main highways you would find it impossible to hire even a "rikshaw," because there are no roads for these two-wheeled vehicles. As there are no riding animals you would probably decide to walk and have your baggage carried on a wheelbarrow.

Density of Population. In Shantung one meets twenty times as many people as in the Syrian province. There are villages everywhere, made of

adobe as in Syria, but never with either the domed or flat mud roofs that are common in Syria. Sloping roofs, usually thatched, are needed to shed the heavy summer rain. The villages are sometimes surrounded by trees as in Syria but often stand bare and gray in the midst of the fields. The mountain slopes are not given over to flocks and shepherds as in Syria. Wherever they are not too steep they are covered with terraces, each of which is a little field banked up with a wall of stone or earth. Out on the plains, in striking contrast to the Syrian province, the population is more dense than among the foothills. No room here for nomads and camels, or even for many domestic animals in comparison with the number of people. A cow or a horse needs several times as much land for its support as does a man. So numerous are the villages that there is land enough to raise food for only a very few animals except pigs and chickens, which do not need room for pasture, and can be fed on refuse.

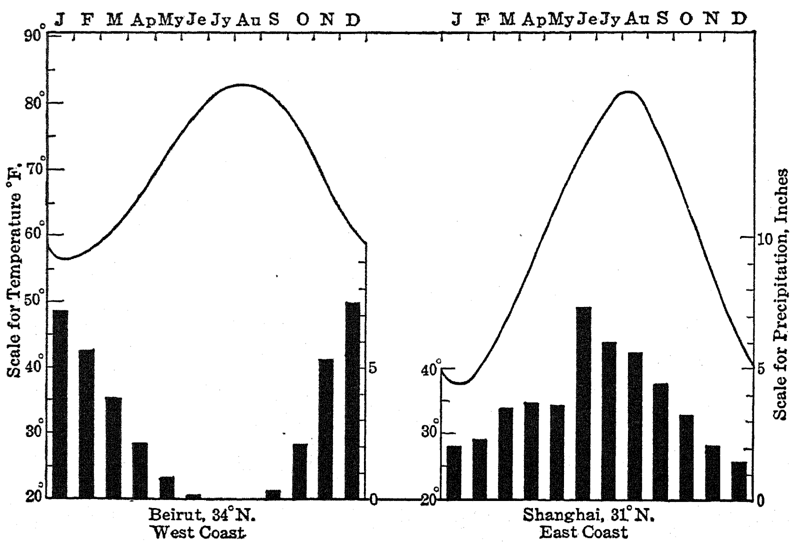
How Intensive Farming Is Carried On. In Shantung small fields and gardens seem to be the rule rather than broad fields such as we saw in Aleppo. This is no place for complicated farming machinery; it is the land of the hoe. In southern Shantung, both men and women are wading about in rice fields, pulling up weeds and repairing little dams in the irrigation channels. Elsewhere the chief crops are wheat, millet, Indian corn, and vegetables. Some of the people are carefully carrying refuse to the fields in pails to serve as fertilizer; others are hoeing the ground for a new crop after radishes, beans, or peas have been harvested. Still others are setting out seedlings that have been raised in beds as our greenhouse men raise tomatoes and pansies. Thus two or three crops are often procured where we would raise only one.

How the Monsoon People Supply Their Own Needs. So busy are the people that they scarcely take time to sleep. Even in winter they work harder than the peasants of most countries. In their homes they weave cloth, make rope, and prepare their crude utensils. They also economize in every possible way. For example, they mend their clothes till the patches hide the original cloth. It would seem as if manufacturing ought to thrive among such people, but in recent centuries they have not shown much inventiveness, and they have been too poor to accumulate much capital. Hence manufacturing has made little progress. Accordingly it would seem as if the enormous population of China would offer a fine market for cheap cloth, knives, hoes, and other inexpensive manufactured articles. But they cannot buy even these cheap things in large numbers. The trouble is that, because the people are so numerous, they have extremely small farms, often only an acre or two for a whole family. So

they are wretchedly poor and have only slight purchasing power. Droughts and famines increase the poverty.

The Contrasted Effects of Winter and Summer Rain

Winter Rain and Summer Drought. As we have already seen, the striking difference between the provinces of Aleppo and Shantung on the two sides of Asia is due largely to the rainfall—not the amount, for in that respect Shantung has only a slight advantage, but the season at which it falls. In A420 compare the diagram for Beirut in Syria with the one for Shanghai in China.



A—Subtropical versus Monsoon Climate.

In the subtropical climate of Aleppo abundant rain normally falls during the winter from November to March, but the summer from June to September is practically rainless. Hence corn, beans, potatoes, and most vegetables will not grow well without irrigation. The same is true of oats, rye, millet, and the kinds of wheat and barley that are planted in the spring. On the other hand, *winter* wheat and barley grow excellently without irrigation. The seed is sown in October and November, when the rains first become abundant; it sprouts before the weather is cold, grows a little during the mild, open winter, and is ready to grow rapidly in March, April, and May. The dryness from May onward is favorable to ripening, and makes the work of harvesting easy, since there is little trouble from storms. The fields of stubble furnish pasture for

animals during the dry summer when other pasturage is especially difficult to find.

The Monsoon Type of Summer Rain and Winter Drought. Look again at A420, and note the contrast between the two diagrams. When the subtropical rainfall of Turkey is coming to an end in May, the monsoon rainfall of China is beginning. China gets its rain in the warm season when it is most needed. That is why the population is so dense. Since the rains fall on mountains and plains alike, all the land that is not too steep can be cultivated. There is little room for roads or for cattle. The whole country is a vast patchwork of gardens. Wheat and barley thrive best in the north; millet, corn, beans, and root crops such as beets and turnips grow excellently everywhere; rice flourishes in the south. Millet and rice are the staple foods in such a climate. They yield good returns under intensive cultivation. This type of agriculture is highly characteristic of monsoon regions and is another reason why they are able to support so large a population.

Why Famines Occur in Regions of Seasonal Rainfall

In one respect subtropical and monsoon countries are alike. Both are particularly liable to famines. To begin with monsoon countries, famines are worst in China and in India. Long ago in the years 1344 and 1345 India experienced such a terrible famine that even the Mogul emperor is reported to have been unable to obtain sufficient food for his huge household. As recently as 1877 five million people are said to have perished from hunger in India, and almost ten million in northern China, while in every recent decade millions of people have suffered. In both countries drought is the cause of the most prolonged famines. Since practically all the people are closely dependent upon agriculture, the prosperity of both countries depends upon a short season of abundant rain in summer. Every few years the rains are either scanty or come so late that the crops cannot mature before the end of the growing season. Sometimes, too, the delayed rains pour down in such a deluge that they flood the rice fields too deeply and destroy the prospects of those seemingly fortunate ones who have been able to start their crops by means of irrigation. Elsewhere the heavy rains gully the slopes and carry away the precious soil that should raise the crops of future years. Disasters by flooding are most severe in China, while the failure of the rains has probably produced the worse effects in India.

Subtropical countries occasionally suffer from famines which would be as bad as those of China and India if the population were equally dense. Syria, for example, has lost its people by the hundred thousand on account of drought. Its famines are caused by the failure of the rains

either to begin at the proper time in the fall or to continue late enough in the spring.

Such famines are one of the important reasons why most monsoon and subtropical regions are backward. As equatorial regions are held back by excess of rain, so these regions suffer from insufficient rain. A drought of a single month at the critical time is enough to cause dire distress. For generations the people have suffered such disasters which have destroyed their human and animal capital and helped to make almost everyone hopeless and therefore inefficient. One of the most interesting questions of the future will be to see how fully the Zionists in Palestine with the advantages of good government, modern methods, and abundant capital can overcome the handicaps which have hitherto retarded the drier subtropical countries.

The Leading Subtropical Countries

Lands Near the Mediterranean. The most populous subtropical countries do not suffer from famine as do those of Asia, for they are located in Europe and have a better rainfall than the rest. They are Italy, Spain, and Greece. With them may be grouped the countries of North Africa that border the Mediterranean Sea. Since Europe, Asia, and Africa really form one great land mass penetrated by such gulfs as the Mediterranean and Red Seas, this whole group of countries actually lies in a position corresponding to that of California. They are so important that the term "Mediterranean climate" is perhaps more appropriate than "subtropical climate." Their population (100 million people) is four times as large as that of the subtropical regions of the rest of the world, but probably not much more than one sixth as great as that of the monsoon regions of Asia.

On the whole the Mediterranean countries are more advanced than the Aleppo province which we have used as a type. Even Italy, however, although the most progressive, is behind California. All alike are notable for extensive irrigation, for wheat, barley, olives, and grapes as well as many fruits such as figs, apricots, mulberries, and in many places oranges and lemons. All also raise many sheep, goats, and donkeys. Yet they differ greatly. For example in Turkey and Morocco most of the farmers use crude wooden plows tipped with bits of iron; they thresh the grain under the feet of oxen, and winnow it by throwing it into the wind. In Greece and Tripoli such plows are also used, but less commonly. The threshing floors are often of stone; a roller, or a sledge with short teeth like a harrow, is used for threshing, and a hand machine for winnowing. In Spain, wooden plows are found in out-of-the-way regions, but many modern steel ones are imported, together with some threshing machinery.

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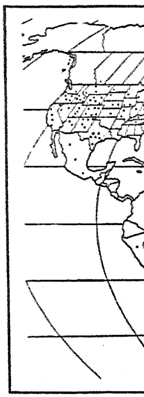

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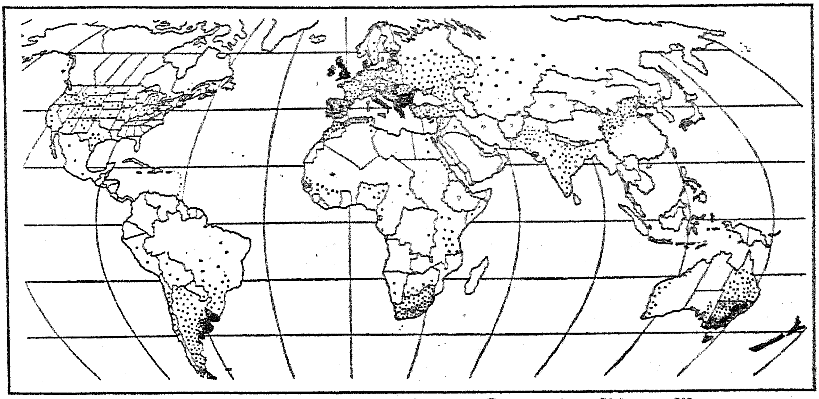
The Italian island of Sicily is as backward as any part of Spain. In North Italy almost everyone uses modern implements, although generally of a simple type, but this part of the country has practically a cyclonic type of climate.

The Fortunate North American Subtropical Region. Although the southern half of California has a typical subtropical climate, it is more favored than even the best of the corresponding Old World regions. The chief reason for this difference is the summer temperature. The California winters have about the same temperature as those of similar locations around the Mediterranean. The summers near the Pacific Coast, however, are not nearly so hot as those of the Mediterranean regions. Thanks to the presence of the cool Pacific Ocean the summer tempera-



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Distribution of Sheep. Sheep are one of the most important products of subtropical or Mediterranean regions.

ture at Los Angeles averages about 11° F. cooler than at Beirut, which lies in the same latitude and is directly upon the coast instead of 20 miles inland. Similar differences prevail throughout the coastal regions. Hence California has a great advantage, for the energy of the people is not sapped by extreme heat, and the ground does not become parched so rapidly through evaporation. Another advantage of California is that its mountains are much higher than those of Aleppo and Syria, and therefore furnish much larger and steadier supplies of water for irrigation.

Subtropical Farming in California. (1) THE PASTORAL STAGE. Agriculture is the great industry of California. The products of the farm are worth far more than those of all the mines, oil wells, and quarries. Even the manufacturing industries, aside from petroleum refineries, consist largely of the preparation of farm products.

The agriculture of California has passed through three stages in which grass, grain, and fruit, together with vegetables, have been successively the most important forms of vegetation. The first white settlers were Spaniards from Mexico. They depended largely on grass, for they raised cattle in enormous numbers. The animals throve on the broad plains. There the thick green grass, which is so lovely in the spring when it is spangled with bright flowers, is equally nutritious when it becomes dry and brown in the summer. Up to 1848 hides, horns, and tallow were almost the sole Californian products. So eager were the Spaniards to make room for more cattle that they killed large numbers of surplus horses. So numerous were the horses that an ordinary living horse was no more valuable than his hide.

The discovery of gold in 1848 and the consequent increase in population checked the cattle industry, for bread as well as meat was wanted by the new settlers. In 1862-64 a fearful drought, such as sometimes comes to subtropical countries, gave a still greater check, for it destroyed thousands of cattle. Then sheep raising assumed great importance until the flocks threatened destruction both to the forests and to the grasslands where the sheep nibbled off the seedlings and grasses to the very roots. In the drier parts of California and among the mountains cattle and sheep are still the mainstay of many of the people, but elsewhere they are much less important than in better-watered states such as Wisconsin and Montana.

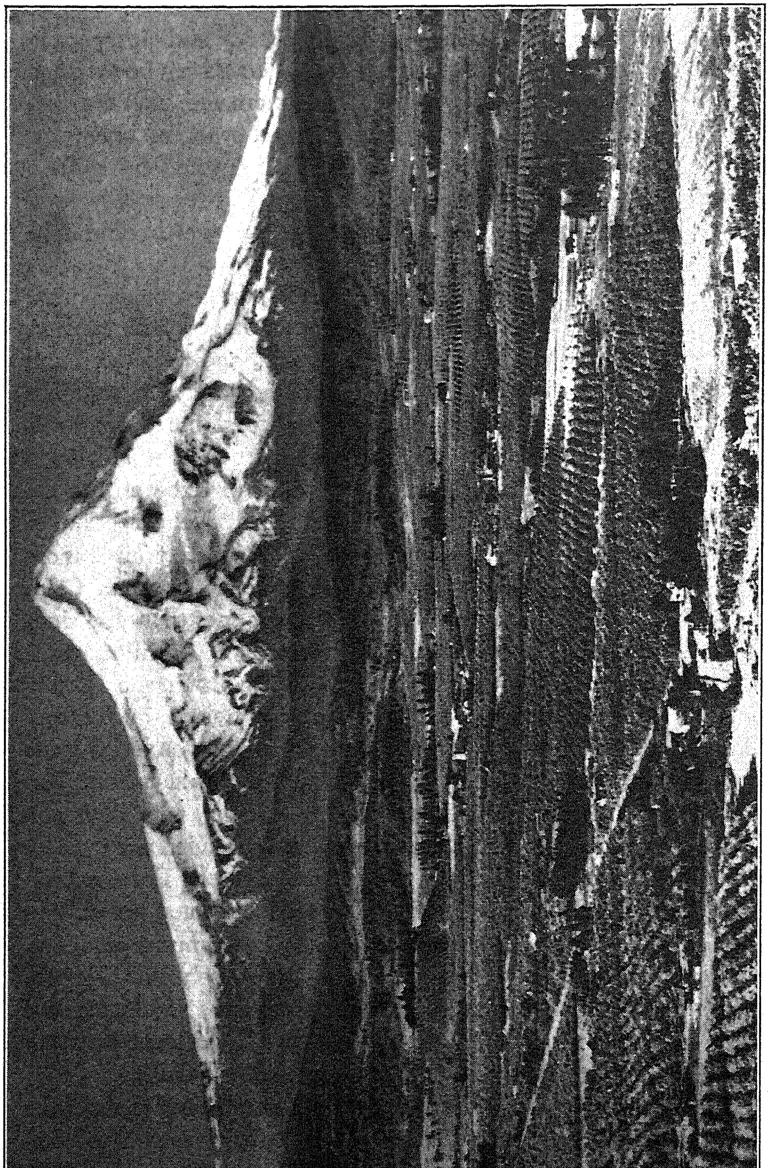
(2) THE WHEAT-RAISING STAGE. After the discovery of gold, a second stage of agriculture began in California. Wheat became the staple crop, just as in the subtropical regions of Italy and Turkey. The size of the ranches accordingly decreased, while the population increased. Wheat raising, to be sure, requires large farms, but not nearly so large as cattle raising. In 1850 the average ranch contained about 4,500 acres, and some comprised several hundred thousand. Ten years later the average farm was only one tenth as large. By 1925 the size had fallen to about 200 acres, but since then it has risen. Nevertheless some farms are still so enormous that in the morning ten or twenty plows start from the barns and take half a day for a complete trip across the field and back. Big farms of more than 1,000 acres have increased considerably in number of late, as have small ones under 100 acres in size. The middle-sized ones are declining.

The level nature of the great interior valley and the size of the wheat farms have led to the introduction of remarkable machinery. Great gang-plows drawn by tractors or by twenty or thirty horses plow a dozen or more furrows at a time. Harvesting machines are equally wonderful. Drawn by twenty-five or thirty horses, or by gasoline tractors, these com-

bines, as they are called, cut, thresh, and sack the standing grain in one operation at the rate of two bushels a minute. Such machinery can be used best in regions where the harvesting season is dry and sunny as in subtropical California, for only the thoroughly dry kernels can be threshed while the grain is being cut. The work of one man with modern machinery in California harvests as much grain as the work of twenty or thirty in Turkey. Since 1880, when California harvested 54 million bushels of wheat, the production has fallen off, but this is partially compensated by a greater amount of barley. Much land which cannot be irrigated is better for grain than for anything else.

(3) THE FRUIT-RAISING STAGE. So long as California devoted itself largely to raising cattle and cereals the chief advantage of its farmers over those of Turkey lay in greater energy and skill, and more land and hence more wealth. During the last forty years, however, the state has reaped another great advantage from the abundance of the water in its mountains. Today California depends for a large part of its wealth upon irrigation. The irrigated farms are generally of small size and are devoted chiefly to fruit and vegetables. With the possible exception of parts of Italy and Spain there is no part of the world where fruit is more abundant. The beautiful plum orchards of such places as Santa Clara County contain 20 million trees, and furnish more prunes than any similar areas in the world. Equally remarkable are the 280 million grape vines covering hundreds of square miles of vineyards in Fresno County and elsewhere. The California grape is known everywhere, and is converted into famous raisins and grape juice. A still more wonderful scene is the orange groves of the south, especially in the valley from San Bernardino to Los Angeles. Among the 17 million trees, with their polished leaves and symmetrical round shape, many are so loaded with yellow oranges that one scarcely can believe them to be natural. For the high quality and great abundance of its fruit California is indebted not only to irrigation, but also to the dry sunny weather in the summer and fall. How important this is may be judged from a comparison with Florida. Although that state raises a quarter as many oranges as California and a far larger supply of grapefruit, it raises less than 1 per cent as many grapes, apples, pears, peaches, plums, and other orchard fruits.

The necessity of exercising great care in order to sell their fruit in the distant markets of the East has led the California fruit growers to combine their interests. Practically every community has a cooperative packing house where fruit is cleaned, sorted, and packed, and from which it is shipped to meet the demands of the market. In the hands of a people who are full of ambition and energy, the great natural resources of California



Keystone View Co.

A—A Complete Picture of Irrigation in California. This picture is complete because it extends from the snowy reservoir of the high mountains through the forests of the lower mountains to the fertile lowland where rich orange groves now replace the scanty grass and scrubby bushes of the days before irrigation.

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together with such cooperative enterprises have made the state the most prosperous and progressive of all subtropical regions.

(4) THE LATEST STAGE OF THE PACIFIC STATES. The three agricultural stages of California have now merged into a fourth stage. This, too, depends upon climate, but scenery, manufacturing, commerce, and oil wells also play important parts. As time has gone on, the beautiful scenery of the coast and of the high mountains has combined with the climate to attract at least three kinds of people. One kind is tourists who are drawn to the coast by such places as Santa Barbara and Monterey and to the mountains by Yosemite with its waterfalls and cliffs, the high Sierras with their glaciated peaks, and the famous Big Trees in their national parks. The coolness of the coast in summer, and its comparative warmth in winter combine with the scenery to attract new residents who are able to make their homes in whatever place they consider most pleasant. The fact that many prosperous people want the most pleasant place in which to settle down for the rest of their lives helps to make California one of the world's most wealthy regions. Hollywood and the moving-picture industry are a conspicuous response to this combination of climate and scenery.

Another part of the new phase is due to the fact that our relations with Asia are steadily increasing. All four of the great Pacific cities—Seattle, Portland, San Francisco, and Los Angeles—are centers from which steamship lines radiate outward to Mexico, Panama, South America, Australia, the Philippines, China, Japan, and Alaska. Fish, lumber, and wheat go out in great quantities from the northern ports. San Francisco ships miscellaneous cargo in which manufactured goods play a considerable part. Los Angeles, by reason of the abundant oil in its hinterland, ranks close to the top among the world's seaports in the volume of its outbound traffic. Besides all this the western cities, especially San Francisco and its suburbs, are following the example of the North Atlantic and Lake States in becoming manufacturing centers. A few decades ago the manufactured goods on the Pacific Coast came largely from the eastern United States or Europe. Today along first one line and then another the Pacific States are manufacturing enough goods not only to supply their own needs, but also to have something for export. One of the most interesting phases of the geography of the West Coast is its approach to self-sufficiency. No other region with the Mediterranean type of climate has such great advantages geographically, or has gone so far in using its advantages.

The Mild East-Coast Region of America

The southeastern corner of the United States belongs to the same mild east-coast type as southern China, according to Plate II. The coastal part from Georgia to Texas belongs to the monsoon type, since the prevailing winds blow out from the continent in winter and inward in summer. No part of the Atlantic Coast, however, shows a rainfall of the purely monsoon type, for cyclonic storms supplement the monsoon rains. In summer the rainfall of Georgia, as appears in A112, is of the typical monsoon character. By November it has fallen off so that it seems to promise a dry season, but cyclonic storms cause the rain to increase again. Except for the heavy frosts which sometimes follow in their wake, and the consequent damage to the Florida orange groves, these storms give the southeastern United States a great advantage over southern China and India. Not only does the occurrence of rain at all seasons prevent such complete crop failures as afflict the Asiatic monsoon countries, but also the frequent storms bring stimulating changes which help to make the people energetic.

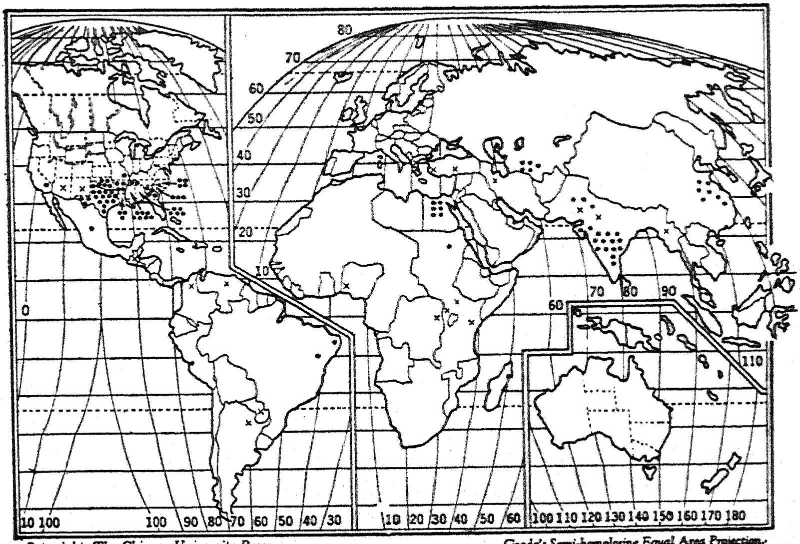
Farther north, with more cyclonic storms, the rainfall of the Carolinas shows only a little monsoon influence, and is almost as abundant in winter as in summer. One result of this type of rainfall is that the South Atlantic States are by far the world's greatest producers of cotton (A429). Although production in other countries is increasing, and although the boll weevil has done much harm, the United States (A430) still produces two fifths of the world's cotton.

Why the American Monsoon Region Has Fewer People Than the Asiatic Regions. Since the southeastern corner of the United States combines the advantages of abundant monsoon rain in summer and cyclonic rain the rest of the year, we should expect a dense population. Florida, however, has less than 30 inhabitants per square mile, and even Georgia, in the center of the world's chief cotton belt, has only about 50, while the monsoon regions of China and India have several hundred.

Here are some of the reasons for this: (1) In Florida the relative sparsity of population is due partly to the abundance of swamps such as the Everglades. A more important factor, both in Florida and the neighboring states, is the large amount of sandy soil which is in constant need of abundant fertilizers. In all warm wet regions the soil does not have enough humus because vegetation decays so rapidly. In India and China, however, the monsoon regions with the densest population contain great delta lands and broad floodplains, where the great rivers regularly spread water and silt over the fields and renew their fertility.

(2) Although the monsoon climate of the South Atlantic States is highly favorable for agriculture, it has not encouraged immigration.

The United States was settled mainly by people from the cool, stimulating climates of northwestern Europe. Such people can live and prosper in the southern states, but, as they themselves say, they do not have so much energy as in the North. This is especially true if they attempt to work in the fields and endure the sun and heat of summer. For this reason, as well as because of the presence of a colored laboring population in the South and the demand for labor in the North, immigrants from northern Europe have preferred to go to the northern states, which until recently have offered so much unoccupied territory and so many growing factories that there has been room for everybody. These same conditions have



A—World Production of Cotton.

taken people away from the South. Many of the white people have gone west, and since the first World War many Negroes have migrated to the manufacturing cities of the North. These conditions are rapidly changing. One reason is that immigration has been restricted. Hence any special demand for labor in any part of the country must be met by migration from other parts. Both Whites and Negroes are moving back and forth from North to South much more than formerly. Another factor is that many competent men are making strong efforts to build up agriculture in the South, and especially to persuade people to plant many kinds of crops instead of only cotton and corn. Along the coast winter vegetables play an important part in this trend. A still greater change has

come about through the growth of the cotton-manufacturing industry especially along the "Fall Line" from Richmond to Atlanta and beyond.

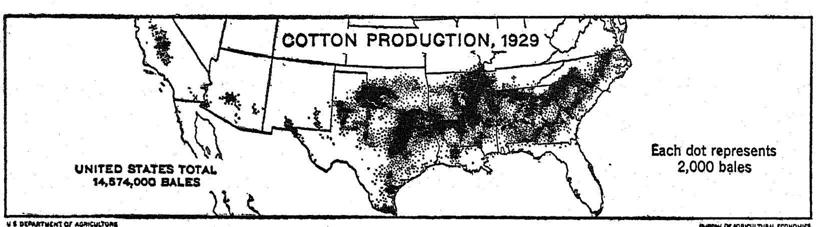
In spite of these changes the South still has the good fortune to have a scanty population compared with that of the monsoon areas of Asia. America is still new, even though we think of the Atlantic States as old. Accordingly the people have plenty of room. This has been one of the great factors in keeping our standards of living high. The farmers have been able to get as much land as each could cultivate, no matter how hard he might work. This has meant a large surplus over and above the mere needs of food, clothing, and shelter. The high standard of living thus set by the farmers is reflected in the rest of the population. If the farmers had to be content with tiny farms of three or four acres like those of China, our whole level of prosperity would fall.

QUESTIONS, EXERCISES, AND PROBLEMS

1. From maps of products in this book make two maps showing contrast between subtropical and monsoon regions. Insert names of places mentioned in connection with Aleppo and Shantung. Add chief products; also the important steamship routes which connect these regions with the rest of the world. Insert blue arrows for prevailing winds in winter and red for those prevailing in summer. On the basis of the maps explain which of these two regions has the greater advantages.

2. Look up what J. Bruhnes says about architecture and physical geography in *Human Geography*. Apply this to the facts stated in the present chapter. Compare the various parts of the United States in this respect. Give examples from your own region, and from any other region with which you may be familiar. Suggest reasons for each fact you state.

3. Make diagrams showing the percentages of the world's production of wheat, barley, cotton, and rice raised by India, Spain, and Italy, respectively. For each of the diagrams prepare a written statement of the conditions of physical geography which favor the crop.



A—Cotton Production in the United States. 1929.

4. Make a list of three to six of the most important products falling in each of the following classes: (1) cereals, (2) root crops, (3) vegetables, (4) fruits, (5) fibers, (6) narcotics or stimulants. From maps in this book (see Index under "Maps") or in other books or atlases, such as the *Geography of the World's Agriculture* (published by the United States Department of Agriculture), classify the

products as follows: (1) those produced abundantly in (*a*) subtropical countries; (*b*) monsoon countries; (2) those produced moderately in (*a*) subtropical and (*b*) monsoon regions; (3) those produced either not at all in such countries or only in small quantities.

5. Look up the cotton boll weevil. Study A478 and A466, in order to see where the boll weevil probably came from and what it has done to cotton production in the southern section where it has been longest established and thrives best.

6. In what type of climate does A429 show cotton to be most abundant? Discuss the reasons for its abundance in the United States compared with China and India.

CHAPTER XXII

IRRIGATION

Wide Extent of Irrigation

People who live in lands that receive rain at all seasons find it hard to realize the importance of irrigation. Look at Plate II, and see how large a part of the earth needs irrigation. Wet and Dry Low Latitudes, Deserts, Regions of the Mediterranean Type, and Monsoon Regions all need it. In fact, wherever there is a dry season, especially if the weather is warm at that time, irrigation is an enormous advantage. Except in the south all the 250 million people more or less who depend directly upon agriculture in India would practice irrigation if they could, because they have a long and warm dry season. Even though the supplies of water are limited, about a fifth of the cultivated land is irrigated. In China a similar condition prevails. Even in the south, where some rain falls even in winter, irrigation is a great help, and is practiced wherever possible. In the north, where the rains do not begin till May or even June, the farmer who can lead water to his fields is very fortunate. So, too, in Chosen and Manchuria, where droughts do a vast amount of damage. Regions such as Japan, Indo-China, Siam, the Malay Peninsula, and the East Indies do not suffer from drought as do the northern halves of India and China, but they have a warm dry season in most parts, and they raise rice. Therefore irrigation is there developed on an enormous scale.

Even this does not complete the list of regions where irrigation is important. Inasmuch as all countries with the Mediterranean type of winter rains also have the disadvantage of summer droughts, irrigation is highly developed in California, Chile, parts of Australia, and especially around the Mediterranean Sea. Deserts and dry continental interiors feel a similar need. Thus more than half of all the farmers in the world need irrigation and practice it where possible.

Examples of Irrigation

1. *Ancient Empires.* The parts of the world where civilization first rose to high levels all depended on irrigation. Forty or fifty centuries ago the Tigris and Euphrates supplied water for the Chaldeans and

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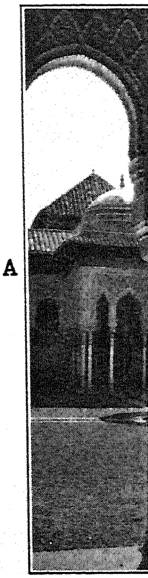

A. A courty
B. Columns
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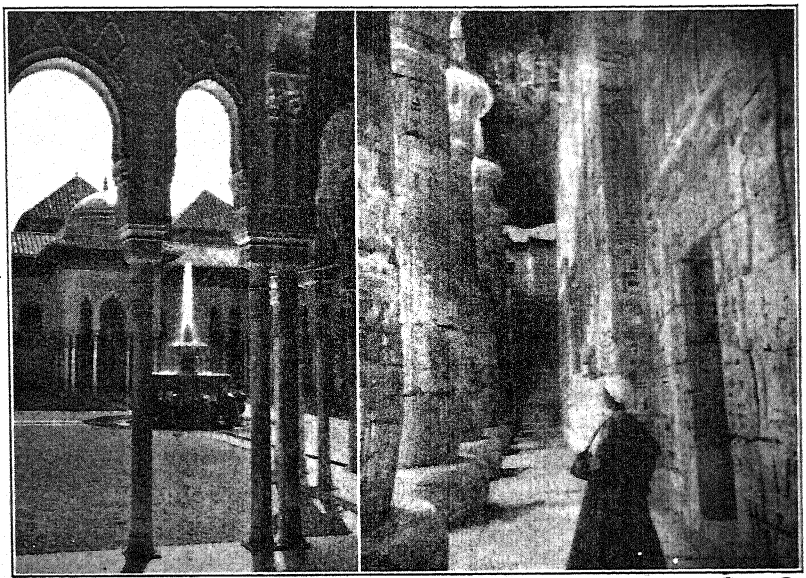
Babylonians and later for the Assyrians. Egypt then, as now, owed its life to the Nile. The Persians have always depended on irrigation, whether they lived in their own country or extended their sway over the Tigris-Euphrates plain. Palestine, Greece, Italy, and Carthage are also great regions for irrigation, although they depended and still depend mainly on small streams instead of great ones like the Tigris, Euphrates, and Nile. In India another great river, the Indus, together with the upper branches of the Ganges, also supported an early civilization by means of irrigation. In China, too, the earliest civilization grew up in the dry

A  B

Keystone View Co.

A–B—Two Samples of Old Architecture.

A. A courtyard in the Mediaeval Alhambra at Granada in Spain.
B. Columns, walls, and hieroglyphics in the very ancient Egyptian temple at Karnak on the Nile.

irrigated region of the upper Hwang Ho. Far away in America the early Incas of Peru depended on irrigation so much that they carried out some of the most amazing feats of engineering in constructing canals among steep and lofty mountains. Before the days of the Incas an earlier civilization grew up on the desert coast of Peru where the modern sugar plantations are located. No crops can be raised there without irrigation. In our own country the highest aboriginal civilization was that of the Pueblo Indians of New Mexico, who depended largely on crops raised by irrigation.

2. *Egypt.* In Egypt, nature makes it remarkably easy to practice irrigation on a large scale. The White Nile, or main stream, comes from three of the great lakes of Central Africa which serve as reservoirs and give a large supply of water at all seasons. The Blue Nile and the Atbara come from the highlands of Abyssinia and are subject to great floods which cause the river to overflow its banks during the summer. Thus at that season the river not only waters the land without exertion on the part of the farmers, but in addition fertilizes the fields with rich alluvium. In order to equalize the flow of water and make irrigation possible at all seasons the great Assuan Dam has been built.

A voyage up the narrow lake above the dam on a steamer bound for Wadi Khalfa is most interesting. On each side steep cliffs rise hundreds of feet to the plateau of the Sahara Desert. For the most part they are black or dark brown, but here and there a golden cascade seems to be pouring over them. It is sand swept forward from the desert by the wind. At the base of the cliffs, close to the water, one frequently sees lines of flat-roofed mud houses. "What are they here for?" one asks. "How can all those people get a living with nothing but water on one side of them and cliffs and desert on the other?" But come in the summer or fall and you will see. At that time the water behind the dam is gradually drawn off to irrigate the fields of Egypt. When a narrow strip of the lake floor is laid bare by the retreating water, the villages close by plant it at once. When the lake has disappeared and there is only a river the whole lake floor has been planted. In that hot climate the crops ripen before the dam is closed again.

3. *Some of India's Irrigation Projects.* In India one single irrigation project on the Chenab, a tributary of the Indus, waters 2,500,000 acres and supports a million people. The British government built the Chenab Canal to increase the production of grain, vainly hoping thus to relieve the severe overcrowding elsewhere in India. Before any land was assigned to settlers the fields, streets, and village sites were all laid out in what was then a desert. Places for the post office, bazaars, and government offices were assigned, and everything was ready. Then 800,000 people poured in within eight years. The canal cost 9 million dollars, and today the crops *each year* are worth about 12 million. Since ancient times southern India has been full of "tanks" or small ponds built for irrigation where little valleys have been dammed to hold the water of streams that are in many cases temporary. In recent decades all sorts of clever schemes have been devised for bringing water from places where it is plentiful to those where it is scarce. For instance, the Cardamom Mountains at the southern end of the western Ghats receive 80 or 100 inches of rain and the plains to the east only 20 or 30. Accordingly, the Periyar River drain-

ing these mountains on the wet west side has been made to flow through the mountains in a tunnel a mile long. Emerging on the east side it waters the dry plains near the city of Madura.

4. *Irrigation in the United States.* The people of the eastern United States are like those of other moist regions in not realizing the importance of irrigation. In the entire country, to be sure, only one farm in forty is irrigated, and in the eastern half irrigation is used only under special conditions, as in market gardens. Nevertheless in the western part 1 million people live on 15 million acres of irrigated land. Moreover, events like the terrible droughts of 1930, 1936, and especially 1934, made hundreds of thousands of farmers elsewhere wish for irrigation.

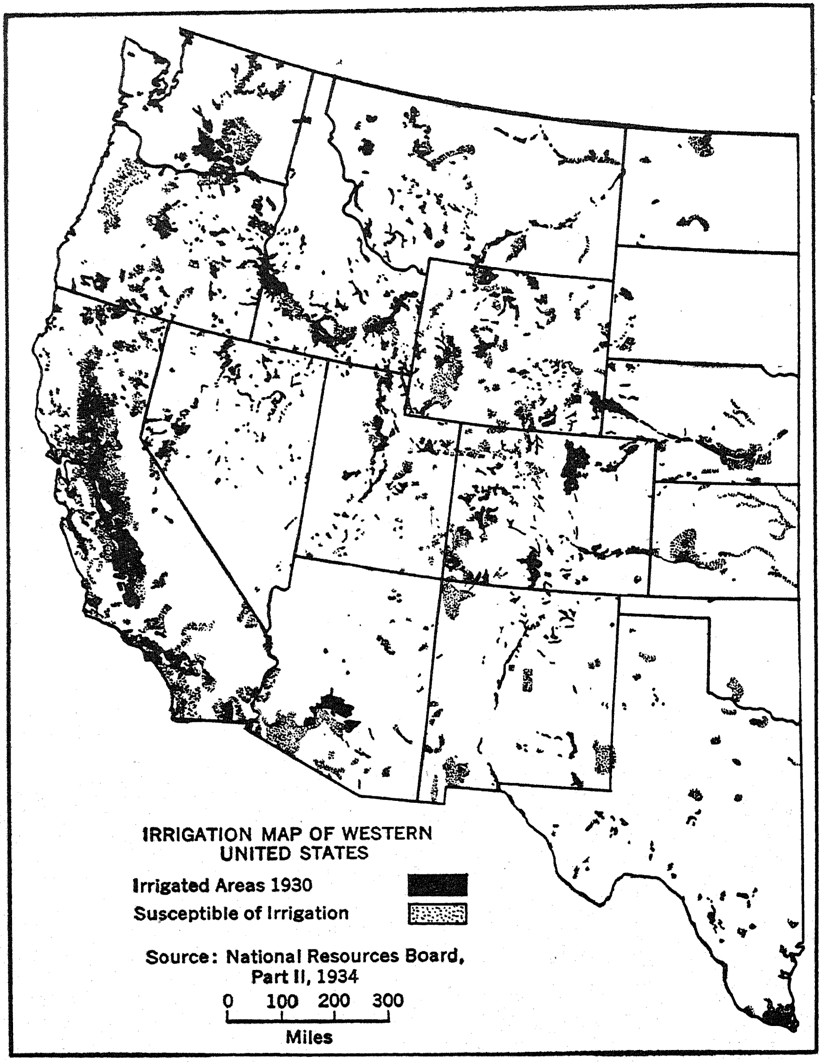
The distribution of irrigated land in this country is illustrated in the following table and in A436.

IRRIGATION IN THE UNITED STATES

	A Percentage of Area Capable of Irrigation	B Percentage Irrigable 1940	C Percentage of Farms under Irrigation 1934
Utah	4.1	2.9	79
Nevada	1.5	1.1	79
Idaho	7.0	5.3	63
California	16.7	7.3	61
Arizona	2.2	1.6	53
Colorado	7.6	6.2	48
Wyoming	6.5	3.0	45
New Mexico	1.4	1.0	41
Montana	4.1	2.7	27
Washington	6.2	5.1	22
Oregon	5.7	2.1	20
Nebraska	3.5	1.4	4
Texas	1.4	0.7	3
South Dakota	0.5	0.2	1
Kansas	2.5	2.3	1

The first column of figures shows what percentage of the total area of each state can ultimately be irrigated; the second shows the percentage that will be ready for irrigation when water reaches the million and a half acres of the Grand Coulee project on the Columbia River. All the irrigation projects, both public and private, include 28½ million acres, or considerably more than half of the 51 million which may possibly be irrigated some day. The third column (C) shows what percentage of all the farms is irrigated. In such a state as Arizona the splended Roosevelt Dam waters 270,000 acres and Boulder and Imperial Dams on the Colorado River add still more. Nevertheless there is not water enough to

irrigate much more than 2 per cent of the total area, and only about three fourths of this has thus far been utilized. This small fraction, however,



A—Irrigation in the United States.

Note the relation of irrigation to (1) mountains (Sierra Nevada, Rockies, Coast Range, Uinta, and (2) river valleys (Columbia, Snake, Green, Rio Grande, Arkansas, Platte, and many others.

includes 53 per cent of the farms in the state. The remaining 47 per cent are mostly cattle ranches and will probably never be irrigated.

California is much better off than Arizona. Because of its high mountains it possesses enough water so that 16.7 per cent of the land may some day be irrigated. This is a respectable percentage of all the good farm land, for a large part of California is too rugged ever to be farmed with much profit. The largest single irrigation project in California is in the Imperial Valley. There the waters of the Colorado River, which till 1900 flowed unused through a desert, now support some of the richest farms in the United States. The level alluvial plains and warm dry climate of this region with its excessively hot summers closely resemble those of Mesopotamia and Egypt. Naturally the crops are similar and consist of such items as winter vegetables, dates, silky Egyptian cotton, and rare varieties of melons which grow almost nowhere else in the United States.

Utah and Nevada depend on irrigation more than any other states, for about 90 per cent of their farms have an artificial water supply. So dry are these states, however, that, in spite of the streams coming from the great Wasatch and Sierra Nevada Ranges, the area included in irrigation projects is only 3½ per cent of Utah and 2 per cent of Nevada.

During the 1930's the combined effect of the severest industrial depression and the severest droughts ever experienced in the United States led to great activity in the construction of new irrigation projects. Among the 50 highest dams in the United States about half date from that decade. Some of these, such as the huge Fort Peck Dam on the upper Missouri River, were built primarily to control floods. Others, such as the Bonneville Dam on the lower Columbia, were designed to aid navigation. Electric power and water supply for cities were other purposes. Irrigation, however, was the main purpose of many, including Boulder Dam on the Colorado River, the highest dam in the world (727 feet), and Grand Coulee on the Columbia River, which is one of the highest (550 feet) and also the most expensive ($120,000,000). When this last dam is fully operating it will irrigate about 1,200,000 acres, and will raise the percentage of irrigated land in Washington considerably higher in the preceding table. It is interesting to see how many of the world's greatest rivers have been dammed in such a way that their water can be used for irrigation as well as for power, flood control, or navigation. These include the Nile at Assuan; the Blue Nile near Khartum; the Euphrates and Tigris in Iraq; the Indus and its main branches and some branches of the Ganges in India; the Po in Italy; and the Missouri, Columbia, Colorado, and Rio Grande in the United States.

The Conditions of Irrigation

The Part Played by Mountains. Irrigation depends largely upon the presence of mountains. This is partly because mountains receive more

precipitation than the dry lands at their base and partly because mountains act as reservoirs. The ground water which seeps into them in the rainy season gradually flows out through springs at lower levels. If the mountains are high enough so that snow lasts till summer, the water is set free when it is most needed for irrigation. That is one reason why India has developed irrigation more highly than any other country. The fact that both the Ganges and the Indus flow from mountains covered with perpetual snow does more than any other one thing to make it possible for a fifth of all the cultivated land of India to be irrigated. Nevertheless the fact that the peninsula of India is an old dissected plateau with many gentle valleys where ponds can be dammed also plays an important part. A flat plain, such as that of Sudan, with a similar wet and dry low latitude climate is far less habitable because there it is difficult to get water and impossible to raise crops half the year, except on the Nile and close to the foot of the Ethiopian plateau. When Italy conquered Ethiopia the British were much worried for fear the Italians would divert the waters of the Upper Nile at Lake Tanna, but there is little danger of this. Northern Italy is fortunate in the same way as northern India, but more so. It not only has the snows of the Alps to serve as a reservoir, but also some of its rivers such as the Ticino and Adda pass through the beautiful Lakes Maggiore and Como which aid in keeping their flow steady and in preventing floods.

In the preceding table of irrigation in the United States note how the presence of snowy mountains influences the percentages in the first column of figures. Nine per cent of the lands of Colorado are included in irrigation projects because that state has great plains lying at the base of the snowy Rockies. A unique irrigation project is located in this state. The Gunnison Valley contains a large river, but only a little flat land, while the neighboring Uncompahgre Valley contains a small river and plenty of flat land. To bring the water to the land where it is needed a tunnel 6 miles long has been dug through a ridge of mountains, so that the water of the Gunnison River is now turned into the Uncompahgre Valley. Idaho and California, as well as Colorado, receive large streams from snowy mountains, and hence the percentages in column A are comparatively large. Arizona, New Mexico, and Nevada do not have such high mountains and are less fortunate. Nevertheless, the snowy Rocky Mountains supply the summer flow of the Rio Grande and the Colorado River, as well as of the Columbia far to the north.

Artificial Reservoirs and Waterpower. Where the mountains are not high enough to give abundant water throughout the dry season artificial reservoirs must be made such as the Roosevelt Reservoir in Arizona, or the tanks of India. The chief trouble with reservoirs is that unless great

precautions are taken they ultimately become filled with silt. India is full of old tanks that have thus gradually been converted into smooth plains which are now cultivated with the help of irrigation from newer tanks. On the lower Heri Rud, where that river flows from Afghanistan into the Asiatic part of the U.S.S.R., the authors once saw a dam behind which the river valley had been completely filled with mud in a few years. The river meanders this way and that, and keeps threatening to cut a new channel around the end of the dam.

In modern projects, as we have seen, it is customary to combine irrigation with the production of power and with still other purposes. A good example of this is the Boulder Dam at Boulder Canyon on the Colorado River near the point where that river finally turns south. The enormous dam raises the level of the river about 600 feet. It thus forms a lake nearly 100 miles long which extends back through wild country into the lower part of the main canyon of the Colorado River. The water stored in this way supplies power which is used in Los Angeles more than anywhere else. It also helps to prevent floods by holding back floodwaters which can be used to irrigate the Imperial Valley and other land along the lower Colorado. In addition to this the lake is a wonderful place for tourists. On its smooth waters one can sail into the heart of the vast Grand Canyon and explore an almost endless number of superb side canyons with precipitous walls of black, gray, green, red, brown, and yellow rocks over which hang sheets of lava that froze while pouring into the canyon.

Methods of Raising Water for Irrigation. In many places the demand for irrigation cannot be met entirely by supplies of water that flow to the fields from mountains or reservoirs. The additional supply must be raised mechanically from streams or wells. One of the most primitive methods of doing this can be seen in Egypt along the banks of the Nile. There the brown-skinned peasants fill buckets suspended from one end of a pole which moves like a seesaw. With the help of a weight at the other and shorter end they lift the water to a higher level. There it is raised again by another "shadoof," as the apparatus is called, and so on until it reaches the level of the fields. In India the most familiar means of raising water is from wells by means of a large leathern bag, suspended by a rope passing over a pulley. When the bag is filled two bullocks attached to the end of the rope are slowly driven down an incline, thus raising the bag, which is emptied into a sluice leading to the fields.

These Oriental methods contrast vividly with the practices in many of our own irrigation projects where the water is raised by efficient pumps driven by windmills, gasoline engines, or electricity generated by the

irrigation water at the dams higher up the valleys. Such methods, however, are so expensive that they cannot be used for ordinary crops. What is needed now is some means of reducing the cost of power. If solar engines were practicable and cheap, irrigation would be possible in many places where it is now out of the question, for the constant sunshine would furnish abundant power at low cost.

Human Responses in Irrigated Lands

Special Advantages of Agriculture. The farmer in irrigated regions enjoys seven distinct advantages: (1) Although the soil of dry regions, as we have already seen, is usually deficient in humus, it is often peculiarly rich in other plant foods. The meager rain carries away only a small portion of the soluble ingredients. (2) In addition to the abundant plant food in the original soil new food is often provided by streams which deposit mud. This serves as a fertilizer. (3) Since the sun shines much of the time in irrigated regions, growth is rarely hindered by cool, cloudy weather. (4) Neither do the plants suffer from drought or from too much rain, for they can be given as much or as little water as is needed. (5) Weeds do not grow as they do in wet countries. (6) The fruits grown on irrigated lands can be dried easily and cheaply. (7) Hay and grain always ripen perfectly and can be harvested without getting wet. In rainy lands vast quantities are often spoiled by being rained on at harvest time.

Thus many circumstances combine to produce large crops with only a moderate amount of labor. In the United States the value of the crops on an acre of the irrigated land is from 25 to 65 per cent greater than in the country as a whole.

Chief Crops in Irrigated Regions. (1) HAY. The most valuable irrigated crop in the United States is alfalfa. It occupies 30 per cent of the irrigated land, and often yields from three to five crops each year. One reason for its special value in dry regions is that it takes nitrogen from the air and thus makes up for the lack of humus. Other kinds of hay crops occupy another 30 per cent of the irrigated land. This is not surprising in view of the fact that in the United States as a whole, hay is more important than any crop except corn.

(2) FRUIT. The irrigated crops that come next in value in the United States include grapes and orchard fruits such as prunes, cherries, peaches, and apples. Subtropical fruits such as the orange and lemon vie with these in importance. In other subtropical countries, where fewer animals are kept and less hay is needed, the importance of fruits is even greater. For instance, the chief money crop of Greece is little seedless

grapes which we buy under the name of dried currants. Without them many Greeks would not know what to do for ready money.

(3) RICE. Although relatively little rice is raised in the United States, it is the most important irrigated crop in the world as a whole. The crop in this country grows chiefly in the semi-monsoon regions along the Gulf and South Atlantic coasts, but its cultivation is increasing rapidly in California. Ordinary rice cannot grow properly unless its roots are bathed for months in slowly moving water. Monsoon countries practice irrigation chiefly for the rice crop, although other crops need it in the early spring before the rains arrive. Even the so-called "dry" rice is planted in terraced fields which retain the rainwater for many weeks.

Irrigation Supports Dense Populations. Irrigation adds enormously to the density of population. For instance, in the Ebro and Tagus Valleys of Spain much of the land produces twelve times as much as it would without irrigation and therefore supports a corresponding number of people. Utah has an area of 85,000 square miles, but most of the 400,000 people live in the 1,500 square miles that are irrigated. There the population is more than 200 for every square mile, while elsewhere it is less than 1. In Arizona, it is estimated that 1 person is added to the population for every 2 acres brought under irrigation, or over 300 per square mile. In the Libyan oases west of Egypt, which would be uninhabited without irrigation, there are 500 people for each square mile. Egypt is still more remarkable. Its cultivated area, including the long, narrow floodplain and the triangular delta, amounts to about 11,000 square miles, and contains 14 million people. Part of these live in Cairo, Alexandria, and other cities, but even if we omit these there are still about 1,000 peasants per square mile. The habitable part of Egypt is one fifth as large as Iowa, but supports 5 times as many inhabitants, or 25 times as many per square mile.

The effect of irrigation on the density of population is well illustrated by comparing Mesopotamia and Egypt. Both regions have rivers capable of use for irrigation, and both were densely populated before the time of Christ. Then the people degenerated and were troubled by fierce invasions. Accordingly, in Mesopotamia the dams and canals were neglected, and were ruined by disastrous floods of the Tigris and Euphrates. Hence for centuries the formerly fertile plains had almost no population. Now that this region is under the protection of England, new irrigation works have been built, and in a few generations the population may be as dense as that of Egypt.

How Irrigation Prevents Famine. One of the most important advantages of irrigation is that it prevents famine. In India the British government has spent millions of dollars to irrigate land that needs

water only in years of special drought. One such project cost \$1,500,000. Its ordinary receipts from the sale of water fail by \$60,000 per year to pay interest and running expenses, but in a single dry year, 1896-7, when the crops would have failed without it, this one project enabled the farmers to raise crops worth \$750,000 and saved thousands of lives. How much real good this does it is hard to say, for as soon as the capacity of a country like India to support population increases, the population also increases, and the standards of living remain as low as ever. India today has perhaps four times as many people as two centuries ago when England first began to give it peace and good government.

In Egypt the floods commonly rise 25½ feet above the ordinary low water level at the First Cataract, as the rapids at the head of the lower navigable section are called. In 1877 the flood rose only 20 feet, and the water was unable to reach nearly a million acres of land. Terrible famine ensued, and the government lost \$5,500,000 simply in taxes. The great Assuan Dam was built to prevent the recurrence of such disasters. The narrow lake behind the dam is 200 miles long so that there is plenty of water at all seasons.

Contrast Egypt's experience with that of China. Although China has many small irrigation works, we are frequently called upon to contribute relief for millions of Chinese sufferers from famine. The trouble is that China's rivers create a problem far worse than that of Egypt. The Nile sends down a flood regularly at the same time each year. The people know what to expect, and can put their villages on mounds high enough to escape ordinary floods. China's rivers send floods some years but not others, and the date when the flood comes varies, although it is always in summer. Thus the Chinese do not know what to expect and cannot prepare for it. Egypt's river flows in a narrow valley, rarely more than 10 miles wide. So if the flood is unusually high, the peasants can easily escape to the higher land a few miles away. Moreover, since most of the villages are near the river there are plenty of boats. In China the rivers flow across broad plains where the land seems as flat as the ocean for hundreds of miles. But the rivers flow in shallow grooves on the top of low ridges above the level of the plain. When a flood comes there is no knowing where a river will break its bounds, or how far it will depart from its old course. The trouble with China is that its problem is much too big. When the same problem in a far milder form confronted us in the Mississippi floods of 1927 we failed lamentably to control the river in spite of all our resources and machines. In addition to her primitive irrigation, China needs great dams, canals, and aqueducts, not only to provide water in times of drought, but also to control the water in times of flood. If China's great rivers could be

properly regulated the people would be saved from untold suffering. If the growth of population could be checked, this would allow the standards of living to rise. Thus the wealth per capita as well as the total national wealth would rise, to the benefit of other countries as well as of China. The purchasing power of the country might increase so much as to make a difference of scores of millions of dollars each year in the trade of the United States alone. All this illustrates the close relation between the progress or prosperity of a country and the magnitude of the problems presented by its geographical environment.

How Irrigation Promotes Civilization. Irrigation is one of the strongest agencies in promoting civilization. The earliest civilizations grew up in Egypt, Mesopotamia, northern India, and China, where irrigation has always been of the highest importance. Irrigation promotes civilization in at least five distinct ways: (1) People who practice irrigation cannot wander from place to place as do primitive savages. They must stay in one home. Hence every improvement that they make in their houses or fields is of permanent value and stimulates them to do more.

(2) Such people learn to have forethought, for otherwise their ditches and dams will not be ready, and their crops will not grow. They also learn industry, for they cannot put off their work. If the water is led onto the fields too late or allowed to remain too long there will be a poor harvest. Forethought and industry are at the base of all advances in civilization.

(3) Irrigation also promotes civilization by teaching people to live in peace and submit to the will of the majority. Suppose that a number of farmers settle along a small stream in a new country. In a dry year those living farther upstream are tempted to take too much water, thus insuring good crops for themselves, but ruining those of the people farther downstream. When such things happen quarrels arise at once. In our own western states, when irrigation was first begun and before laws had been framed, more than one fight with guns occurred for just these reasons. During his travels in Asia one of the authors of this book once had an Afghan servant who had fled from his country because he killed a man in a quarrel over irrigation. Such conditions, however, cannot continue. People soon realize that, if anyone begins to tamper with the water, all the rest run the risk of serious loss because their own crops may be left dry. Hence strict laws are passed, and public opinion usually enforces them sternly. When people learn to obey the law so carefully in one respect, they tend also to obey in others. Accordingly, as a rule, few places are more peaceable and law-abiding than irrigation communities even among people otherwise low in the scale of civilization.

(4) Irrigation also helps to teach self-government. For example, in parts of northern Italy the users of water from a given ditch meet in November and elect representatives to a sort of water parliament representing all who are supplied by one large canal. Each village plans beforehand what crops it will raise the next year. Then the water is divided according to the need of each.

(5) Another way in which irrigation promotes civilization is by causing people to live close together and yet letting each family have at least a fair-sized piece of land of its own. In California, for instance, the irrigated farms, especially those where fruit is raised, are comparatively small and no one feels that he is far from his neighbors. Where people live compactly in irrigated districts, they are able to support good schools, churches, and other helpful institutions.

Why Agriculture Probably Originated in Irrigated Regions. The close connection between irrigation and civilization goes back to the very beginnings of agriculture. Of course we cannot have any exact knowledge of those primitive times. Nevertheless, there is general agreement that agriculture originated in floodplains like those of the Nile, Euphrates, Indus, and Hwang. Put yourself in the place of primitive man. You have no metal tools, and your stone implements are merely arrowheads, scrapers, grinders, and other tools for hunting, preparing skins, or grinding wild seeds. You observe that certain seeds such as wheat and barley are good to eat and keep a long time. The idea of saving seed and planting it comes to your mind, as the result, perhaps, of some accident. Under what kind of environment will this idea prove fruitful? Not in the shade of a forest; not in a prairie where every square inch is crowded with plants already; and not on a sea beach where the salt will kill the wheat. A floodplain is the place which best encourages such an idea. There each flood leaves tracts of bare mud. The seeds need merely to be scattered there, and they will grow. The ground remains moist a long time, for the level of the river and of ground water falls slowly. Other plants do not choke the seed, for they do not get started soon enough. So the primitive farmer can sow his seed, go off to hunt or gather wild seeds, and at length come back to find his wheat ripe and ready for harvest. This in turn leads to other lines of progress. The farmer, if such we may call him, must devise ways of storing his grain not only for food but for seed. And then he and his descendants are led onward to the other steps of progress described in the preceding section, *How Irrigation Promotes Civilization.*

All this illustrates one of the most fundamental principles of geography. Different activities and habits are found in different parts of the world largely because the geographic environment favors them in

some places but not in others. The idea of agriculture may have occurred to people in all sorts of places. They may even have made experiments. But in order to achieve success the experimenters needed an environment where their primitive crops would get water and sun and a chance to grow without being swamped by other vegetation. The muddy floodplains of rivers in dry climates where the floods come regularly in warm weather and leave tracts of fertile mud which becomes dry very slowly were just the places for this.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Use the table on page 435 (Irrigation in the United States) as the basis for a double diagram in which lines of appropriate length represent (1) the area of each state included in irrigation projects; (2) the percentage of irrigated farms. Is there any relation between these two percentages, that is, do they tend to be large or small together? How is each of these percentages related to (*a*) the height of the mountains, (*b*) the percentage of each state which is mountainous, (*c*) the density of the population?

2. On an outline map of the United States insert in each state a heavy line of appropriate length to indicate the percentage of farms under irrigation. Regardless of state boundaries, draw lines to indicate what you infer to be areas showing the following conditions: (1) over 80 per cent of farms under irrigation; (2) 20–80 per cent; (3) 1–20 per cent; (4) less than 1 per cent. In explaining your map use A107.

3. In one of the annual budgets of the government of India, a total expenditure of more than £83,000,000 was planned. Of this, £1,000,000 was set aside for famine relief and almost £4,000,000 for irrigation. In the estimated expenditure for Canada these items are not listed. Explain these facts geographically. Find similar figures for the United States and discuss their meaning.

4. The French recently advanced a project for great irrigation works along the upper Niger River which, it was claimed, would make the region a second Egypt. Test the truth of this claim by a study of the rainfall, mountains, river system, and natural vegetation of the two countries. Write an account of French Nigeria from this point of view.

5. The possibility of irrigating Egypt is largely due to the relief of Africa. Examine Australia and South America to see whether you find any places where the relief and rainfall offer any hope of repeating the history of Egypt.

6. Compare the rainfall of the United States with the irrigation map of the western states. Choose four important irrigated areas in different states. Find out the distribution of rainfall in summer and winter. Show the relation of this to irrigation. Show also what other conditions make irrigation necessary or profitable. In which area would you expect the water supply to be most steady and abundant? Why?

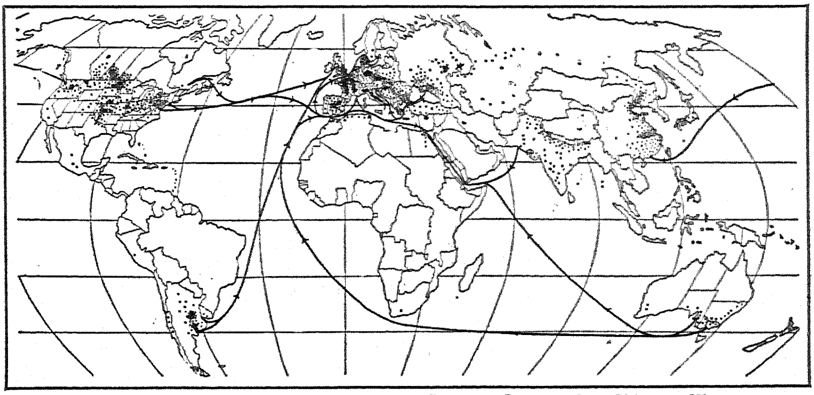
CHAPTER XXIII

MAN'S WORK IN REGIONS OF CYCLONIC STORMS

Characteristics of Cyclonic Regions

1. *Location*. In our survey of human activities we have now come to the most dominant parts of the world. These are the regions of cyclonic storms. They form two irregular belts. The southern belt includes land only in the southern part of South America and a small bit of southeastern Australia together with New Zealand. The northern belt crosses North America and Eurasia at their widest parts. In the western hemisphere it includes most of the United States and southern Canada, and in the eastern, most of Europe. Its central and most important portion consists of two main parts: (1) northwestern Europe from southern Scandinavia through Germany, Great Britain, and France to the northern edge of Spain (No. 9 in Plate II); and (2) the northeastern quarter of the United States as far south as Virginia and as far west as Nebraska (No. 10 with part of 11 in Plate II). In this chapter, however, we shall discuss not only such purely cyclonic regions as these, but also all the regions which have a cyclonic climate more than half of the year. Therefore we include all the well-inhabited part of Canada and practically all of the United States except California, the other dry southwestern states, and Florida. In Europe we include Nos. 9, 10A, and 11, which means all except the greater part of the southern peninsulas, the dry area north of the Caspian Sea, and a northern strip of tundra and cold forest. In Asia we include two parts. One is a slender wedge pressed in between the cold forests of the north and the great deserts of the south. Narrow as it is, it represents practically the whole of the really good part of Asiatic Russia aside from the large oases farther south. That is why it is followed by the Siberian railway. Because it is so limited the possibilities for the growth of population and the increase of civilization in Asiatic Russia are not nearly so great as many people suppose. The other cyclonic part of Asia includes Japan. There the climate is like that of our southern states but more modified by the monsoons owing to the size of Asia. Hence, in spite of cyclonic storms, there is a tendency toward dry winters when the monsoon winds blow outward, and very wet summers when they blow inward.

2. *Climate.* Climatically the cyclonic belts have three chief characteristics: (1) Rain falls in moderate abundance at all seasons; (2) the weather is subject to marked changes every few days. These two characteristics are both due to the frequent passage of cyclones followed by anticyclones. (3) The seasons are strongly pronounced. The winters are cool, or more often cold, and the summers warm or hot. Thus the regions of cyclonic storms are particularly favorable not only to agriculture because of the sufficiency of rainfall throughout the year, but likewise to man because of variations of weather both from day to day and from season to season. In the course of a year they experience samples of the climate of almost every part of the world.



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Map of Wheat Production. Each dot represents 5 million bushels.

3. *Natural Vegetation.* The cyclonic regions, in a state of nature, are usually clothed with deciduous forests, but also include the southern fringes of the great coniferous forests of the northern hemisphere. Some parts also consist of grasslands such as the prairies. The deciduous forests comprise broad-leaved trees such as the birch, beech, ash, maple, oak, elm, willow, and poplar. Pines, however, are frequently mixed with them. Such forests prevail in large parts of the eastern United States, England, France, Germany, and neighboring parts of Europe. The variety of the trees is in accord with the variety of crops which can be raised in the cyclonic regions.

The coniferous forests included in the cyclonic area occupy southern Canada, southern Scandinavia, and central Russia together with certain mountainous sections such as Japan.

The grasslands lie in the interior of North America and Eurasia in the same latitude as the deciduous forests. They occur in places

where, although rain falls at all seasons, continental influences cause it to be less abundant in winter than in summer. Thus, while the American prairies, the plain of Hungary, and parts of the plains of Russia and Siberia have a cyclonic climate favorable for man and agriculture, they are more favorable to grass than to trees.

The Dominance of Cyclonic Regions

1. *Politically*. Although the regions where cyclonic storms are even moderately developed occupy only a tenth of the total land surface of the earth, they support a population of more than 600 million, and include all the world's most progressive countries, aside from a few places such as California with the Mediterranean type of climate, as appears in the two darker shadings of B352.

Thus they include practically all the important parts of the world where manufacturing and commerce, as well as agriculture, are carried on extensively. The inhabitants of the cyclonic regions are so energetic that they raise far more food than those of other regions; they mine most of the world's minerals, and prepare most of the raw materials. They invent and run the world's machinery, construct its great power plants, and prepare its manufactured goods. They also build railroads both at home and abroad; they engineer the great tunnels, bridges, and harbor works in every land; and sail their ships to every corner of the seven seas. Moreover, they govern the world, for among them they rule practically all of Europe, Africa, the Americas, and Australia. Even in Asia they rule all except Arabia, Turkey, Afghanistan, Tailand (Siam), and China together with its former dependencies such as Tibet.

2. *Dominance in Primary Production*. It is most extraordinary to see how largely the articles that enter into the world's commerce come from regions of cyclonic storms. This is true of food and raw materials as well as of manufactured goods. The next page presents a table showing the sources of the world's chief products, aside from manufactures, and of some minor ones. The figures in the table show the approximate percentage of each product coming from the cyclonic regions. Note that out of 90 products only 18 are not produced at all in cyclonic regions, and some of these, such as llamas and mangoes, are of minor importance. On the other hand, 39 belong overwhelmingly to the cyclonic regions, and many of these are of the utmost importance.

One of the significant features of this table is the way in which certain types of products tend to be concentrated in the cyclonic regions, and certain others elsewhere, especially in tropical regions. All the cereals, aside from rice and millet, come mainly from cyclonic regions, even though wheat and barley are raised abundantly in subtropical areas of

SOURCES OF THE WORLD'S CHIEF PRODUCTS AND APPROXIMATE PERCENTAGES OF EACH PRODUCED IN CYCLONIC REGIONS

Nature of Product	Mainly from Cyclonic Regions	Fairly Well Divided between Cyclonic and Non-cyclonic Regions	Mainly from Non-cyclonic Regions
Cereals and forage	Wheat....... 78% Corn......... 85 Oats......... 99 Hay.......... 98* Rye.......... 99 Barley........87		Rice.......... 14% Millet........ 10*
Roots, tubers, legumes, vegetables, etc.	Potatoes..... 98% Peas......... 99* Beets........ 99* Turnips...... 99* Carrots...... 90* Cabbages..... 70* Onions....... 70*	Sugar........ 34% Beans........ 50* Green vegetables...... 60* Garden fruits, melon, tomato, etc...... 60*	Sweet potatoes 15%* Yams........ 0
Fruits and nuts	Apples....... 99% Grapes....... 80* Pears........ 80*	Peaches...... 60%* Plums........ 50* Cherries...... 50* Berries....... 65* Chestnuts, walnuts, etc. 30*	Bananas...... 0% Oranges...... 0 Lemons...... 0 Avocado..... 0 Mango....... 0
Oils	Hempseed.... 98%	Flaxseed..... 32%	Soy beans.... 10%* Sesame....... 1 Peanuts...... 9 Copra........ 0 Rapeseed..... 15 Palm nuts.... 0
Stimulants		Tobacco...... 60%	Coffee........ 0% Tea.......... 0 Cocoa........ 0 Spices........ 0 Quinine...... 0
Industrial plants	Flax......... 99% Hemp........ 98 Hops........100 Wood........ 70*	Cotton....... 60%	Rubber...... 0% Jute......... 0 Henequin..... 0 Manila hemp.. 0
Animals and animal products	Horses....... 70% Milk......... 90* Eggs......... 80* Wool........ 70*	Sheep........ 50% Cattle........ 50 Swine........ 55 Poultry...... 60* Silk.......... 60	Asses........ 17% Goats........ 16 Camels....... 1 Buffaloes..... 2 Llamas....... 0
Metals	Iron......... 99% Zinc......... 98 Aluminum.... 80	Copper....... 65% Lead......... 60 Silver....... 40 Manganese... 34	Gold......... 27% Tin.......... 3
Fuels and sources of power	Coal......... 95% Petroleum.... 70 Lignite....... 99 Natural gas... 99 Water........ 93		
Other non-metallic minerals	Stone........ 75%* Cement...... 95 Salt.......... 86 Nitrates...... 75 Potash....... 99 Phosphates... 80 Sulphur...... 99		

* Very rough estimate.

the Mediterranean Type, and corn in many tropical regions. One reason for this preponderance of the cyclonic regions is that they raise far more per acre than any other parts of the world. The northern United States, for example, gets three times as much corn per acre as the average tropical country.

Vegetables of many kinds are crops of another type that belong mainly to the cyclonic regions. Western Europe and the northern and western United States are the places where vegetables are consumed in greatest variety and in largest amounts per capita. The old idea that China and Japan consume a great many is a mistake. Those countries are so densely populated that they cannot afford to give much space to crops which are bulky but do not have a high value as producers of heat in the body. They cannot raise many ordinary potatoes because their dry springs and very wet warm summers do not fit that crop. Beans grow well, but give so much more food ripe than dry that only a few are consumed green. The cyclonic countries, on the other hand, have far more cultivated land per capita than the others and can afford both space and time for fresh vegetables, to the great advantage of their health. This is preeminently true of the United States and Western Europe.

A similar situation prevails farther down in the table under the heading "Animals and Animal Products." Aside from horses the most important domestic animals are, to be sure, divided almost equally between cyclonic and non-cyclonic regions. Even this, however, means that *per capita* the cyclonic people are two or three times as well off as the rest. If we look at the productivity of the animals, the advantages of the cyclonic regions rise still higher. Their animals are larger than the others, and far more carefully bred to supply meat, milk, eggs, and wool. So it is safe to say that, so far as actual supplies of these products per capita are concerned, the people of the cyclonic area are five or ten times as well off as the rest on an average.

In the matter of fruits, cyclonic regions and the rest of the world appear nearly equal in the table. Remember, however, that the inhabitants of such regions form less than a third of the world's people. Yet they have practically all the apples, four-fifths of the grapes and pears, and at least half of the peaches, plums, cherries, and berries. Moreover, they buy a large share of the bananas, oranges, and lemons raised elsewhere. Thus from the standpoint of health they enjoy the benefits of a fruit diet as well as of a vegetable diet. People who live as we do have slight conception of how little the average Chinese, Hindu, Brazilian, African Negro, or Mexican gets in the way of fresh fruit, vegetables, milk, eggs, or even meat. We of the most-favored parts of the cyclonic areas get

these things daily, whereas these other people get them perhaps once a week or else an oversupply for a while and then none at all for months.

On the other hand, from the standpoint of vegetable oils and stimulants, the advantage is all the other way. The cyclonic regions raise only an insignificant share of the seeds and nuts that furnish oils. Our South, to be sure, forms a warm cyclonic area, because the storms here swing unusually far to the south. Therefore it raises a vast amount of cottonseed and some peanuts, both of which are good sources of oil. It likewise produces much tobacco. But these crops do not put the cyclonic regions on a par with the warmer parts of the earth with their sesame, peanuts, cocoanuts (for copra), and palmnuts, or their coffee, tea, cocoa, and spices.

In the production of industrial plants the cyclonic regions and the rest of the world split about even. They divide the cotton and wood in such a way that the cyclonic regions get more than the others per capita. Hemp, flax, and hops, however, are scarcely as important as jute, henequin and manila hemp, while rubber ranks as the most important of all products which the cyclonic regions cannot supply for themselves.

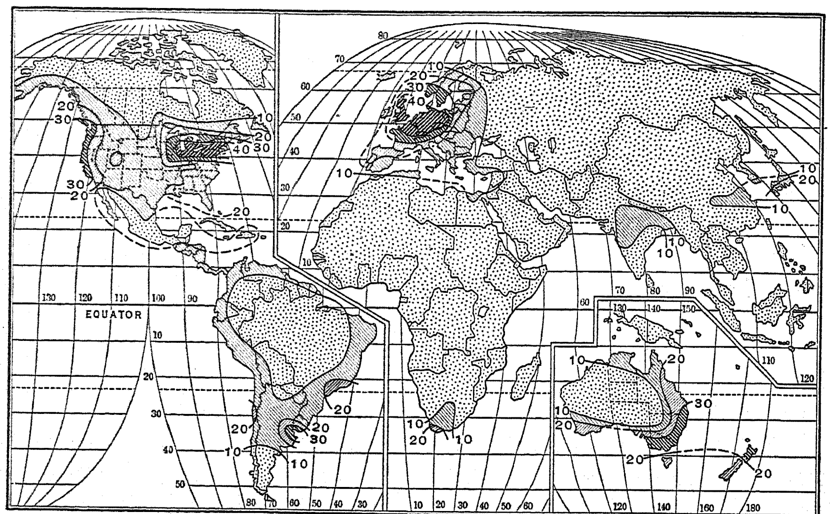
Turning to the minerals we see that the metals, fuels, and other nonmetallic minerals all come overwhelmingly from the cyclonic regions. The per capita production even of manganese is as great there as in the rest of the world, while the most important materials such as iron and coal are overwhelmingly cyclonic products. Only gold and tin really belong elsewhere. This is partly the result of accidents which are very fortunate for the cyclonic regions. Coal, especially, is more abundant there than anywhere else, and the deposits of iron are exceptionally good. Yet the main reason for the enormous production of almost all kinds of minerals in cyclonic areas is the activity and intelligence of the people. They use their resources, whereas the rest of the world lets them lie unused until the people of the more-favored regions come to exploit them.

3. *Dominance in Manufacturing.* The supremacy of the cyclonic regions is even more marked in manufacturing than in primary production. This is illustrated in A452, where the dark areas show the location of active manufacturing. These areas, however, differ greatly among themselves. Only the two larger ones, in the northeastern United States and Western Europe, really do much complex manufacturing. Even such advanced regions as Japan and our South make relatively simple goods for the most part. If we had statistics with which to prepare a map, we should see at once that complex manufactured goods, such as electric motors, mill machinery, motor engines, typewriters, fancy dress

goods, elaborate plumbing, and phonographs, come almost entirely from the main manufacturing areas in the northern United States and western Europe. The more complicated the type of manufactured goods, the more likely it is to be made solely in the most advanced parts of the cyclonic regions. Thus manufacturing is concentrated in such regions even more than is primary production.

Reasons for Supremacy of Cyclonic Regions

The great supremacy of the cyclonic regions is due primarily to a combination of at least five causes which have a definite geographic basis, in addition to non-geographic causes such as education, religion, govern-



Goode's Homolosine Equal-Area Projection: Copyright, The University of Chicago Press.

A—The Distribution of Manufacturing. Percentage of occupied men engaged in industrial pursuits.

ment, inventions, and the like. The more or less geographic causes include (1) the inherited ability of the people; (2) a climate which is highly stimulating to man and unusually favorable to the plants and animals next to be mentioned; (3) food products which are highly nourishing and can be kept a long time; (4) the best kinds of domestic animals; and (5) great supplies of coal and iron.

The inherited ability of the most active European races, which control all the cyclonic areas except Japan, is apparently due in part to the fact that their home is the newest part of the Old World. It is newest because most of it was covered with ice or was too cold to be inhabited for tens of thousands of years during the glacial period

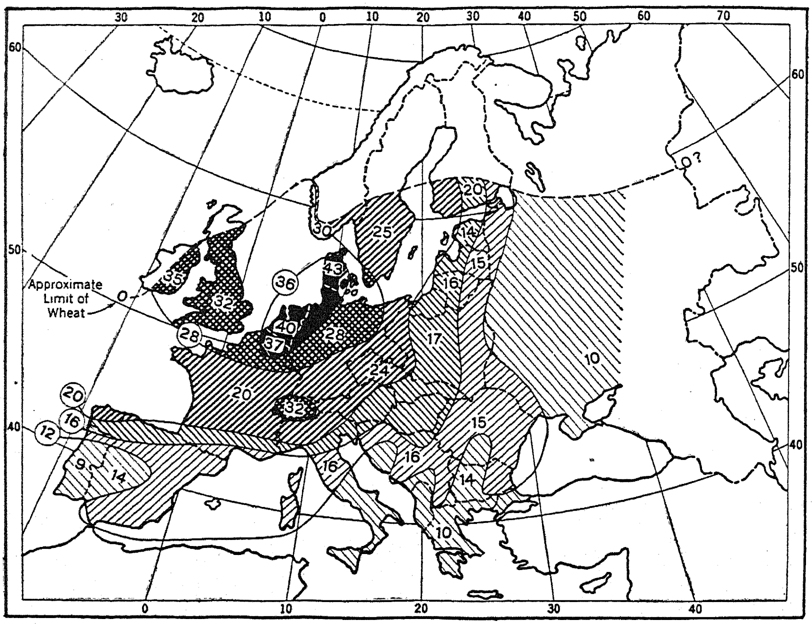
whereas the neighboring lands were habitable. No longer ago than 500 B.C. most of Europe north of the Alps was very sparsely populated. The forests which then covered most parts were almost unbroken by clearings. Thus what are now the best parts of Europe were ready to receive abundant immigrants just as was America two thousand years later. These immigrants came mostly from Asia or Eastern Europe, but some were from the south. Part drifted into the new regions in small groups. Others came in the barbarian invasions which are a famous phase of European history. When people migrate into new regions in this way they encounter great danger, difficulty, and hardship. Hence there is almost sure to be a rigid process of natural selection. As a rule only those who are strongly endowed with what is called the pioneer spirit succeed in establishing themselves. This does not mean that the pioneers have better intellects than the people who stay at home. It does mean that they have more than the average degree of bravery, physical energy, optimism, love of adventure, enterprise, and ability to adapt themselves to new conditions. Those who lack these qualities tend either to stay at home or die out when they emigrate. The death rate among women and children under such circumstances is extremely high, and the vigorous and more intelligent are the most likely to survive. When the whole community possesses the qualities named above, as happens among people who have endured prolonged and difficult migrations, the children for generation after generation inherit them. Thus the migrations into Northern and Western Europe during early historic times, and the further migrations from Europe to the New World and Australia before migration became easy, gave the cyclonic regions an unusually active and adaptable type of inhabitant. The spirit of activity and initiative is part of their inheritance.

As to the climate, we have already seen that the cyclonic climates are rarely handicapped by unduly long summers or by winters that are seriously depressive. More important than this, however, is the fact that the frequent storms make the climate remarkably healthful and invigorating for man, while the frequent rains at all seasons are highly favorable to agriculture. Just how much of the success of the people of the cyclonic regions is due to climate and how much to inheritance, it is hard to say, but these two factors stand back of the others which will now be discussed.

Food Products of Cyclonic Regions

Wheat. In order to gain a clear idea of the conditions which make cyclonic regions so favorable to the production of food, let us examine some of the chief food products and study their distribution as shown

on maps. Most of us suppose that wheat is the most valuable of all foodstuffs, but not till wheat became scarce during the first World War did the world realize how much we lean on this staff of life. Then England, France, Italy, and other countries besought the United States to send wheat, more wheat, and still more wheat. For a time it was more valuable than guns and ammunition; it was the one thing that could not by any possibility be spared. So the United States had to limit its own consumption, and pay bounties to the farmers to persuade them to raise larger quantities of this most valuable of food products.

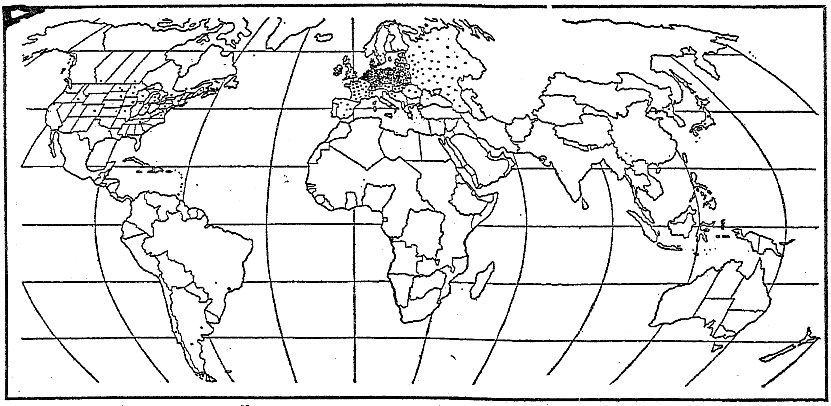


A—Average Annual Yield of Wheat per Acre in Europe. Yield in bushels, 20-year average.

The great value of wheat lies in the fact that (1) its carbohydrates and proteins are very well balanced, so that even if people have no other food they can live on it a long time. In this respect, it is much superior to rice, its nearest rival. (2) It is economically produced. From plowing time until the final product is barreled up as flour all the processes can be performed by machinery. (3) Wheat can be kept a long time either in the form of the whole grain or as flour. In this it is far superior to corn, which would otherwise have an advantage because the yield per acre is so large.

Let us now turn to A447 and see how the production of wheat is related to the cyclonic areas. Although Western Europe is one of the

most densely populated parts of the world, it is also the greatest center of wheat production. Surprising as it may seem, Europe as a whole produces just about as much wheat as all the rest of the world put together. This is not because of the area devoted to the crop, but because in the countries near the North Sea the yield per acre is extraordinarily high, as appears in A454. The cyclonic area of the United States and Canada comes second, and the semi-cyclonic area of central Argentina holds high rank, both in total production and yield per acre. It should be noted, however, that in the regions that raise much wheat to be shipped to a distance the yield per acre is small, the population is sparse, and the farms large. Subtropical and monsoon countries, especially the Mediterranean lands and northern India, produce a good



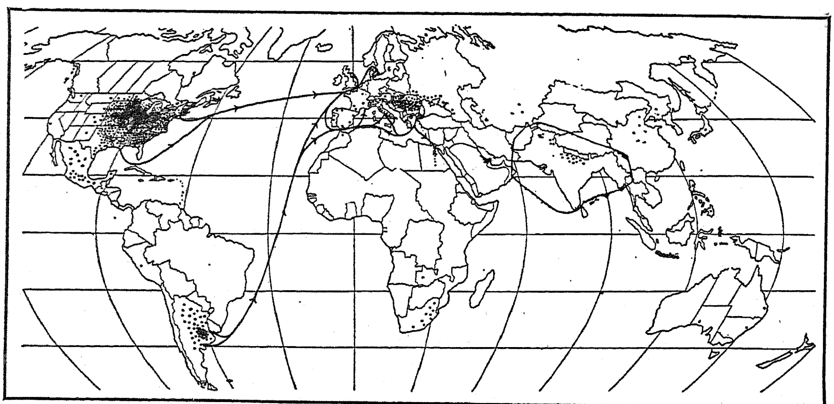
Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Production of Potatoes.

deal, but their production is not a sixth as great as that of the cyclonic regions. In equatorial regions the warm moist climate forbids the growth of wheat. Even in the northern cyclonic regions large areas produce only a little because they are too cool or moist in summer or else too dry or snowy in winter. Wheat wants a region with cool, but not cold, winters, fairly cool summers, and plenty of moisture in the fall and spring, but not too much in summer. It is naturally a product of subtropical regions, where its bearded wild ancestor is still known. Nevertheless through the ingenuity of man it has now become mainly a product of the regions of cyclonic storms. Contrast its distribution with that of rice, A390, which is a typical product of tropical and especially monsoon regions. Bear in mind, however, that the greatest production of wheat, corn, or almost any other crop does not necessarily

or even usually occur where the crop yields the largest return per acre. If that were so Maine and Denmark would be vast wheat fields. But potatoes pay better in Maine, and dairy products in Denmark.

Potatoes. Potatoes, A455, are a cyclonic crop even more strikingly than wheat. Practically none are raised outside the cyclonic regions. From A455 one might almost think that Western Europe is one great potato patch. We think that we raise many potatoes, but Europe raises 90 per cent of the world crop. In Northern Europe this crop occupies much the same preeminent position as rice in the Orient and corn in the Corn Belt of the United States. In Germany, for example, 15 per cent of the cultivated land devoted to crops other than hay is given to potatoes. We speak of *Irish* potatoes because the damp cool



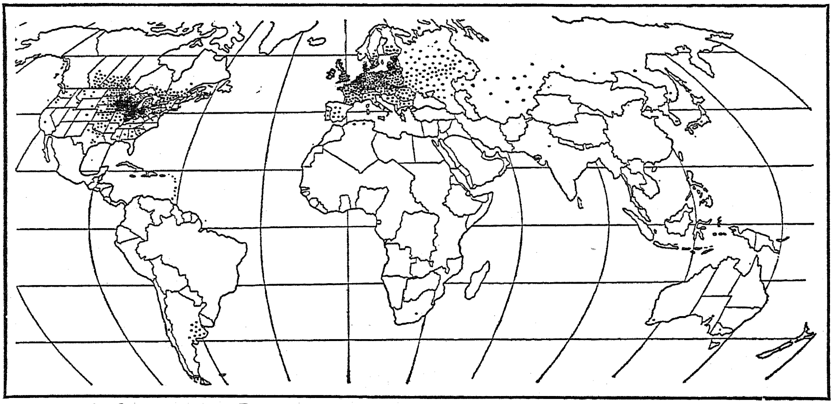
Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Map of Corn Production.

climate causes them to be the chief food in Ireland. The Irish crop, however, is a small matter compared with that of Germany, which is four times as large as that of the whole United States. This explains how it happened that in the first World War the saving of the waste caused by peeling raw potatoes was an important means of enabling the Germans to get food enough when their outside supplies were cut off. It is strange that the potato which originated in the tropical highlands of America should now be raised chiefly in the cyclonic regions of Europe.

Corn. The map of corn, A456, shows an interesting contrast to that of potatoes. Both crops grow most abundantly in the United States and Europe, but not in the same places. Corn on the whole grows somewhat equatorward of potatoes. It needs warm, sunny weather with abundant showers, although very hot days are one of its greatest enemies.

In the United States these conditions occur in the cyclonic belt from Iowa, Illinois, and Ohio eastward. So far as climate alone is concerned Connecticut is probably the best region in the world. Although corn is a more or less accidental crop among the farmers there, the yield per acre (46 bushels as the average for 20 years) is higher than anywhere else except under special circumstances. Nevertheless tobacco, fresh vegetables, milk, eggs, and fruit pay these eastern farmers so much better than corn that for the most part they leave the raising of corn to the Corn Belt from Ohio to eastern Nebraska. In Europe the corn region lies similarly on the southern flank of the storm belt, so that it falls in Italy, Hungary, and Rumania. In South America, again, the main corn area in Argentina lies in a similar position, which means that it is located



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Production of Oats.

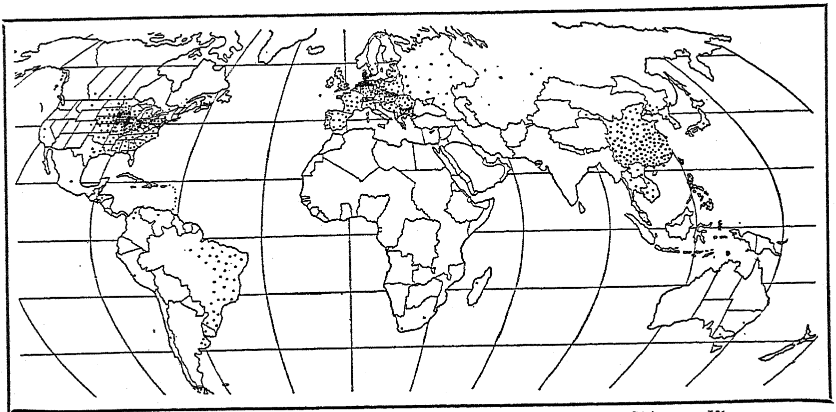
on the equatorward margin of the storm belt. Corn likewise grows outside of the cyclonic belt in places such as Mexico, and also in Egypt and India where it is irrigated. Almost three fourths of the world's crop, however, grows in the United States, while the production in other American countries, especially Mexico and Argentina, equals that of the rest of the world. Corn, quite unlike the potato, is still cultivated chiefly in the New World where it originated. Nevertheless, although corn originated in tropical regions and was mainly cultivated there for many centuries, the superior energy of the people of the cyclonic belt has now caused it to be chiefly a crop of cyclonic areas. Corn, potatoes, and wheat all illustrate the striking fact that if a plant is unusually good for food the people of cyclonic regions take it in hand and both improve it and produce new varieties which will grow where these people want

them. Thus the best varieties and the largest yield per acre are commonly found near the coldward limit. This is true of all sorts of fruits and vegetables as well as of cereals and root crops (A454 and A63). It is one great reason why so large a number of the world's chief food crops grow in cyclonic regions. It also does much to account for the fact that the cyclonic regions raise far more than their fair share of the world's food. Not only do they feed their own dense manufacturing population, but actually export much food to the tropics.

Oats, Rye, and Barley. These cereals, like wheat, were apparently domesticated in Syria or Egypt. When this happened the climate was presumably moister than now. Nevertheless, it is surprising that both rye and oats should now be preeminently crops of cyclonic regions much cooler and moister than those of their origin. Oats, A457, grow in much the same cyclonic regions as potatoes, but are more widely distributed. They are equally good for men and horses (A467), but are so bulky that transportation is more expensive than for most cereals. Hence they are largely consumed close to where they grow and are used for horses more than for men. Rye grows in much the same places as potatoes and oats, that is, farther north than wheat, but within the limits of the cyclonic regions. About 96 per cent of the world's entire crop is raised in Europe, especially Belgium, Germany, and central Russia. It occupies the poorest soils of cyclonic regions as well as the poorest climates, and is eaten by the poorest people. Barley grows in essentially the same places as wheat, but has a shorter growing season and can endure greater aridity and lower temperature. Hence barley increases in relative importance on the edges of the wheat regions, such as North Africa and Turkey, where the climate is dry, and in Great Britain and Scandinavia, where the climate is cool.

Swine. Swine, A459, illustrate the way in which the people of the cyclonic areas take animals, as well as plants, from other parts of the world and make them much more useful than in their native homes. Wild swine of one kind or another are found in most parts of Europe, Asia, and Africa, while their near relatives, the peccaries, occur from New Mexico southward to Patagonia. The wild pigs find it easiest to get a living in the warmer regions, and domestic pigs can be kept in such regions with the minimum amount of work. Yet today the central United States, where there have been no wild pigs for millions of years, has more swine in proportion to the population than any country except Denmark. Other cyclonic countries such as Germany, Hungary, and Argentina also have a relatively large number. Tropical or Oriental countries that have many pigs, for example Venezuela, Colombia, and China, generally have few other domestic animals, and

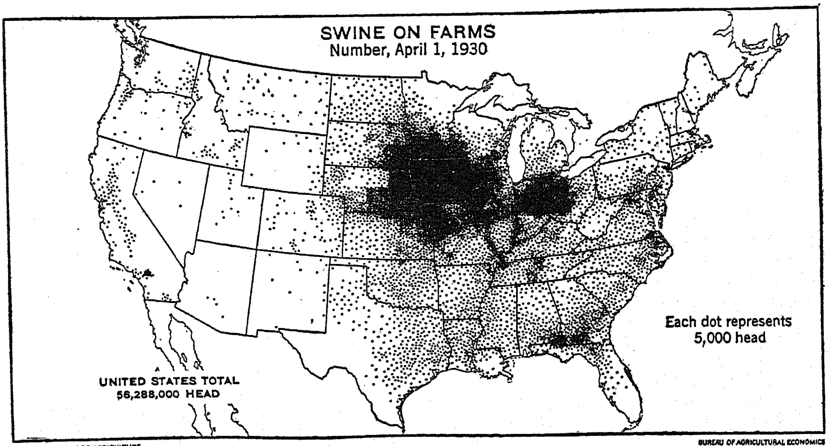
can keep pigs with little trouble. In Mohammedan countries, on the contrary, the use of swine for food is forbidden by religion, and hence, as the map shows, the familiar pigsty is absent in those lands.



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Distribution of Swine.

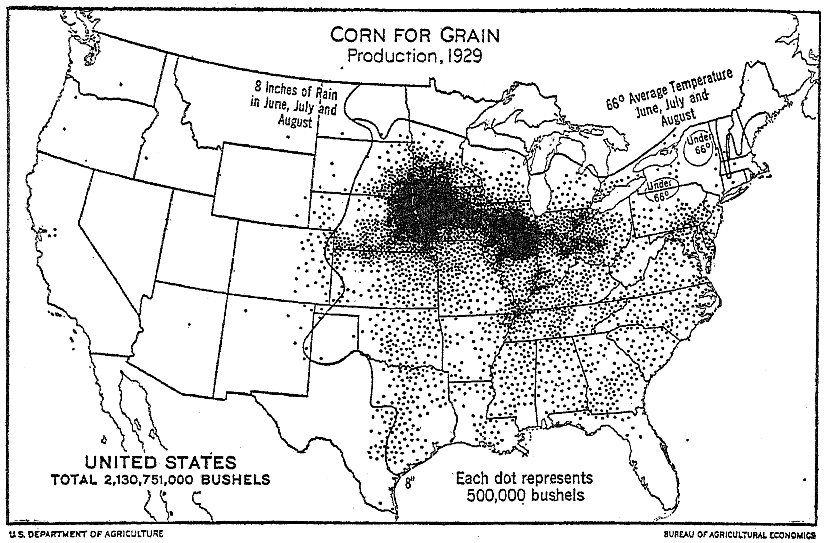
Americans often suppose that swine are usually fattened on corn. This is true in America, as may be seen from A459 and A460. In the more progressive countries of Europe, however, the pigs are fed on barley, po-



A—Swine in the United States.

tatoes, skimmed milk, and root crops, while in Serbia they are often turned out in the oak forests to fatten on acorns. In Germany about 600 million bushels of potatoes, or one and a half times the ordinary crop of the

United States, are fed to the pigs each year. Just as the American farmers of the cyclonic belt raise millions of bushels of corn in order that they may have plenty of pork, ham, and bacon to eat and to sell, so the Germans



A—Corn in the United States.

raise potatoes, while the Danes raise barley, or use the skimmed milk of their cattle after the cream has been taken off for butter.

Cattle as an Illustration of Cyclonic Supremacy

The distribution of cattle, A388, affords still another interesting illustration of how differently people utilize their resources. The map shows four chief cattle areas: two are the great cyclonic areas of the United States and Western Europe which stand out so prominently in many other lines; a third is on the equatorial border of the southern cyclonic region in the American countries of Uruguay and Argentina; and the fourth is in tropical Java and India.

Why the Cattle of India Yield so Small a Return. Let us begin with India and see how little the people exert themselves in cattle farming and how little they get from it. Although India has an enormous number of cattle, a dozen other countries have relatively more in proportion to the population. The Indian cattle are used almost entirely for plowing or for drawing carts. Few are used for food. It is supposed that long ago cattle were so scarce in India that there was great difficulty in getting enough for plowing. Hence it was not considered right to kill them.

This presumably led to a strict religious prohibition which no Hindu dare break even in the direst need. Only Mohammedans kill and eat them. Hence most of the cattle live on and on, and die of old age. When they die a large percentage of those in India are too old to be of much value except for their hides. Most of the cows are not even used for milk, and most of those that are milked are "teacup" cows, as we have seen. This is partly because the grass is poor, being tall and coarse when green, for it grows very rankly in the warm, wet rainy season. After only two or three months of being green, this huge grass dries up and is very harsh and hard to eat during the long dry season. In addition to this, it has been found that even in better climates the yield of milk per cow and the amount of butterfat in the milk are much higher in cool weather near freezing than in hot weather like that of India. Moreover, the people of India have such slight initiative and energy that they make little effort to see that the animals are better fed or that the breeds are improved. Even when the cattle of India die, many of the hides are not used. Thus the Indian cattle yield only a slight return, but this is as much as is warranted by the slight care given them.

Why the Cattle of South America Yield a Moderate Return. The cattle of southern Brazil, Uruguay, and especially northern Argentina are of greater use than those of India. To a certain extent they are employed as draft animals, although horses also do this work, but the main use is for food and hides. As soon as they are large enough they are slaughtered for export. Rarely are they used for milk. This is partly because, although their natural food is better than in India, so that they would give more milk if properly cared for, the pampas grass is not so good as that of cooler regions. Still more important is the fact that until recently the people have believed that it does not pay to care for milch cows, although this is only half true. On many a cattle ranch where hundreds of cows might be milked, high prices are paid for condensed milk brought from the United States. In the more cyclonic parts of Argentina, however, conditions are beginning to be like those in the United States, and butter and casein are exported.

Why the Cattle of Cyclonic Regions Yield a Large Return. In the cyclonic regions of Western Europe and the United States cattle are far more useful than in any other climatic zone. In the United States they do not do much plowing or hauling, to be sure, since they are too slow for that. Yet in the Ozark plateau and even at rare intervals in northern New York or New England yokes of oxen can still be seen at work. Canada uses many. In Europe, however, even in countries such as France, oxen and even cows in many sections are still the main animals for farm work. As a source of food, cattle are vastly more important in

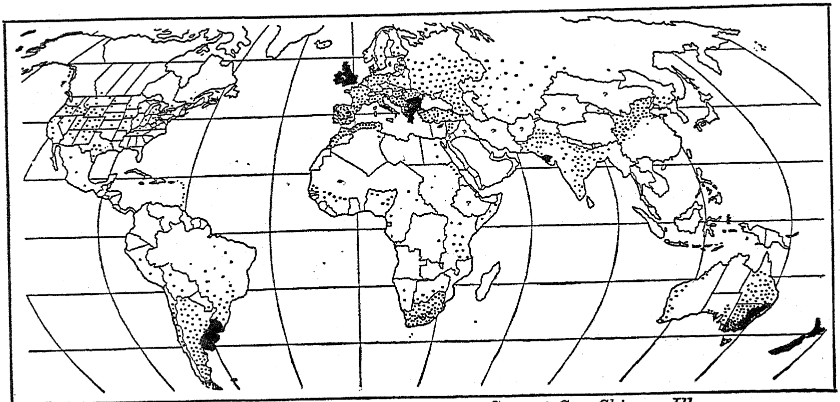
the cyclonic regions than elsewhere, for they furnish protein, which the prosperous people of the cyclonic region can afford to eat. Vast numbers are kept as milch cows, and are tended so carefully that farmers are sometimes accused of giving better care to their cows than to their children. Such care is well rewarded by abundant supplies of milk, cream, butter, and cheese. Some of the animals that are not needed for milk are killed as calves, but more are allowed to grow up. None of those raised primarily for food, however, are allowed to grow old. All are fattened and killed while their meat is still tender. Not only are the hides of such animals used, as in parts of India, or the hides, hair, and meat as in South America, but even the bones, horns, blood, and internal organs are all used for food, fertilizer, glue, and other products. Such great effort in taking care of the cattle for milk, manure, meat, fertilizer, and other purposes, and especially in improving the breeds, is due to the energy of the people of cyclonic regions, but these regions also have other advantages. The cattle raiser in Wisconsin and Holland, for example, is favored with the finest kind of grass, the kind of climate that leads to the production of the most abundant and richest milk, and with great markets close at hand. Thus in cattle raising, as in many other respects, the cyclonic regions are blessed with conditions that are favorable for plants and animals as well as for man.

How the Cyclonic Regions Compare with the Rest of the World in Producing Raw Materials

In the table of world products, the chief raw materials, as distinguished from foodstuffs and fuels, are as follows: (1) iron; (2) copper; (3) lead; (4) zinc; (5) gold; (6) silver; (7) tin; (8) stone; and (9) cotton; (10) wool; (11) silk; (12) flax-fiber; (13) flaxseed; (14) wood; (15) rubber; (16) hides. These materials fall into two great classes: (*a*) eight mineral products the occurrence of which has nothing to do with the present climate, and which are as likely to occur in one zone as another; (*b*) eight plant or animal products which can be raised only in certain regions determined by climate. Let us see where each class comes from and where it is used.

Where the Metals Are Mined and Used. Among the seven most valuable metals, six, namely, iron, copper, gold, lead, silver, and zinc, are so widely distributed that each climatic zone probably has an abundant supply stored away among its mountains. Yet look at A308, A312, A314, and B314, and see where the world's supply comes from. All, except gold and silver, are produced overwhelmingly in cyclonic regions. Iron, the ores of which are very widely distributed, is the one produced most exclusively in cyclonic regions. Tin alone among the seven most valuable

metals occurs almost wholly in one climatic zone, for it is produced mainly in Malaysia and Bolivia. Most of the tin, however, is now mined by European or American companies, and practically all of the product is shipped to cyclonic regions. With most of the other metals, as well as with non-metallic mineral products such as stone, salt, and brickclay, similar conditions prevail. If the distribution of the ores is limited, as is that of gold, silver, and mercury, the mines in other regions are usually run by people from the cyclonic areas. If the minerals are widely distributed in all zones, as are salt, aluminum ores, pottery clays, and road-building stones, they are exploited preeminently in the cyclonic areas. Because of their greater energy and more advanced stage of culture the people of cyclonic regions not only have developed their own mineral



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

A—World Distribution of Sheep.

resources with almost reckless rapidity, but in addition have reached out and procured for their own use the best of what occurs elsewhere.

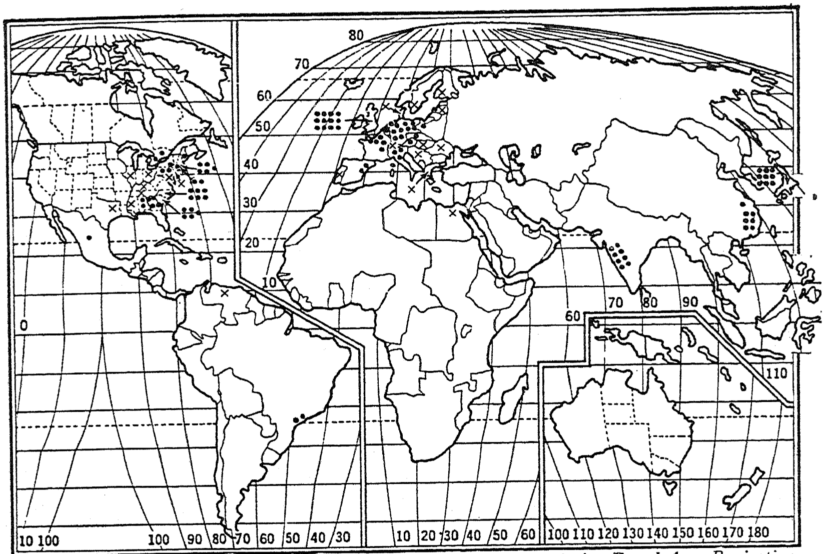
Where the Vegetable and Animal Raw Materials Are Produced and Used. The six most useful non-mineral raw materials, as we have seen, are cotton, wood, hides, wool, rubber, and silk. Unlike the metals, these cannot be produced in many parts of the world. Cotton is a product of monsoon and subtropical climates, or else of regions like our southern states, which combine cyclonic and monsoon conditions. Good wood is common in four of the world's main regions, namely, the equatorial rainforest, the tropical jungle, the deciduous forest, and the coniferous forest. A scattered supply is found in tropical scrub, savannas, subtropical dry forests, and the irrigated parts of deserts. Nevertheless, by far the best kinds of wood for ordinary use are the larger conifers, especially the pines, whose wood is both easily worked and durable. These grow

best on the southern borders of the great coniferous forests and in scattered areas on mountains, or in special soils farther south. Hence they are largely a cyclonic product. North of the cyclonic regions the coniferous forest is relatively stunted and is valuable chiefly for pulpwood for paper (A363).

Wool and hides both come from animals which naturally live in the grasslands of the prairies, steppes, and savannas, and hence are adapted to many climatic regions. Rubber is the only genuinely tropical article of our six, while silk, like cotton, belongs naturally to monsoon and subtropical climates. Thus no one of the six most useful non-mineral raw materials is primarily a product of cyclonic regions, but wood, wool, and hides can be produced there as well as anywhere. As a matter of fact, however, they are produced in those regions far in excess of all other regions. Wool and hides necessarily come from places where sheep and cattle are numerous (A423 and A388), but the production in proportion to the number of animals is far greater in cyclonic than non-cyclonic regions. This is partly because of better breeds, and partly because the animals are killed younger. We think of silk as a product of warm regions, but the bulk of the world's silk supply comes from a cyclonic region, Japan. The people of these cyclonic regions have taken silkworms, just as others have taken cattle and sheep, and have developed types that thrive in climates somewhat cooler or moister than those where the animals originally lived.

Rubber and cotton illustrate the dominance of the cyclonic regions quite as forcibly as do any other products. Rubber does this in the same way as tin, for, although it is a purely tropical product, practically all is exported to a few cyclonic countries and there manufactured. The United States consumes nearly two thirds of the world's rubber. Cotton illustrates the matter in much the same way. B465 shows that the world's cotton crop is limited to fairly warm regions, but the warmest cyclonic region, that is, the southern United States, far excels all other regions. Moreover, as appears in A465, a large part of the cotton crop is carried to the cooler cyclonic regions to be manufactured.

Why Crops Improve as They Are Moved toward Cyclonic Regions. Cotton shows the effect of cyclonic regions in still another way, which we have already discussed briefly. The boll weevil and other pests become less harmful as we go toward cooler regions; the crop is better cultivated; more care is taken in selecting the seed; and the climatic handicaps of drought, unusual heat, and so forth, decrease. Hence the average yield of the crop per acre in the United States displays a general tendency to increase toward the north (A466). Near the northern limit in southern Missouri and Virginia the yield per acre is about twice as great as in



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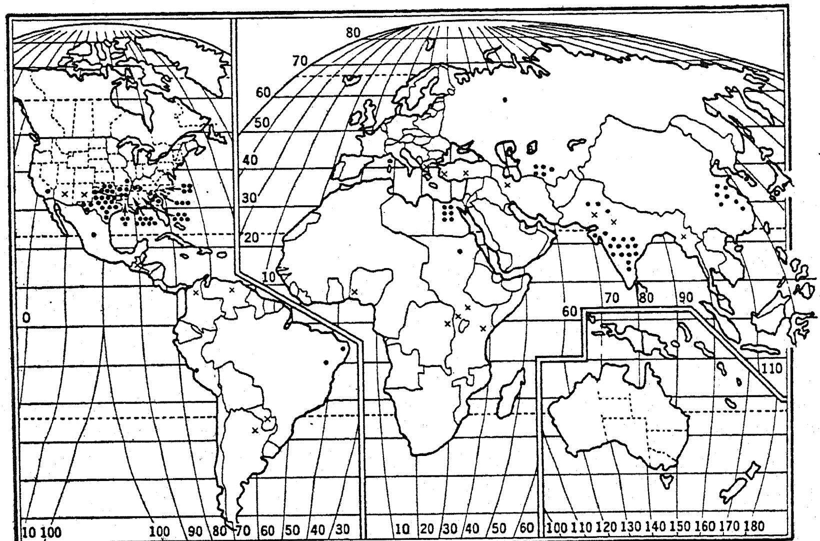
A—World Map of the Distribution of Cotton Manufacturing. Each dot indicates the use of 1 per cent of the world's cotton crop in manufacturing. Crosses indicate minor amounts.



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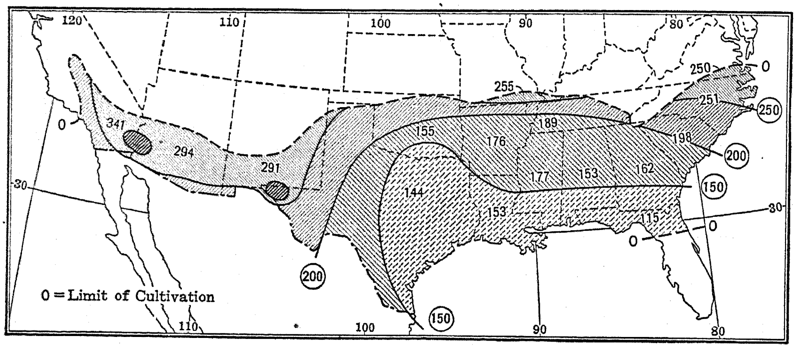
B—World Production of Cotton.

Alabama and Louisiana. In a state of nature the cotton plant, like many others, presumably grows best in about the middle of its range. The best pine trees, for example, grow neither in the far north nor the far south; the holly is a little bush in New England, it becomes a great tree in the southern states, where it thrives best; still farther south it again diminishes in vigor. So, too, with thousands of other wild plants, both great and small. Yet among cultivated plants derived originally from warmer climes, not only cotton, but also corn, wheat, potatoes, oranges, grapefruit, and others grow best near their northern limit. In other words, when these crops are gradually moved toward the regions where man is most competent, their productivity and quality improve because of the care given them and the selection of new varieties, although naturally they might not thrive in their new homes. It should be noted, however, that



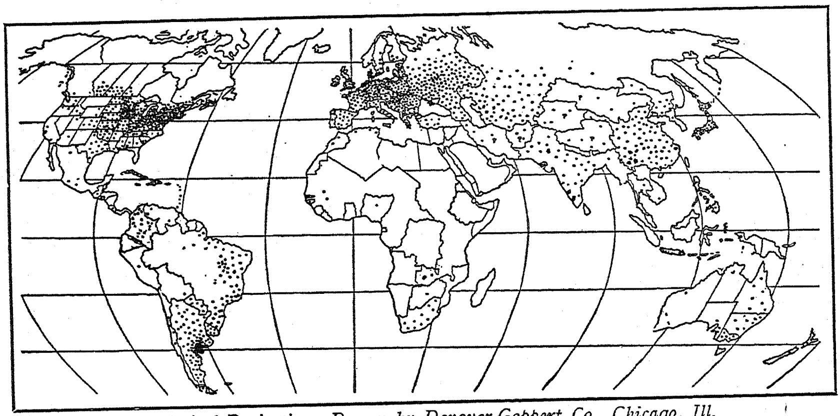
A—Average Yield of Cotton per Acre in the United States. Yield in pounds, 20-year average.

cold winters tend to cause the yield of most crops to decline. Long summers that are not too hot and mild winters are best for many crops, including corn and wheat.

The Supremacy of the Cyclonic Regions in Transportation

A467 and the railroad maps on pages 565 to 571 illustrate the concentration of horses and of railways in the cyclonic regions. How far is this due to other factors than climate? Plains, especially grasslands, certainly have an effect on the distribution of horses, for there are more horses in the grassy plains of the central United States, eastern Argentina, and southwestern Russia than in the neighboring rugged regions. But in the grassy plains of the non-cyclonic regions of the Orinoco, and the Sudan, there are practically none. So, too, railroads are numerous throughout the plains of cyclonic regions, but are absent in the still greater plains of the Amazon Basin, northern Canada, northern Siberia, and Arabia. The

density of the population also has an effect on the distribution of both horses and railways, but how important is this? Compare A467 and the railroad maps with A144, showing the distribution of population. China, Java, and India are among the blackest areas on the population map, yet there is only 1 mile of railway for every 30 square miles of territory in Java, 50 in India, and 270 in China, while there is a mile of railway for every 11 square miles in the United States, 8 in France, 6 in Holland, and 5 in Great Britain. Moreover, both Java and India would probably have a railway net less dense than that of China if they had not received railway systems from their Dutch and English rulers. Thus it appears that, though relief, vegetation, and density of population all have some effect on the development of means of transportation, a still greater effect is



Denoyer's Semi-elliptical Projection. Drawn by Denoyer-Geppert Co., Chicago, Ill.

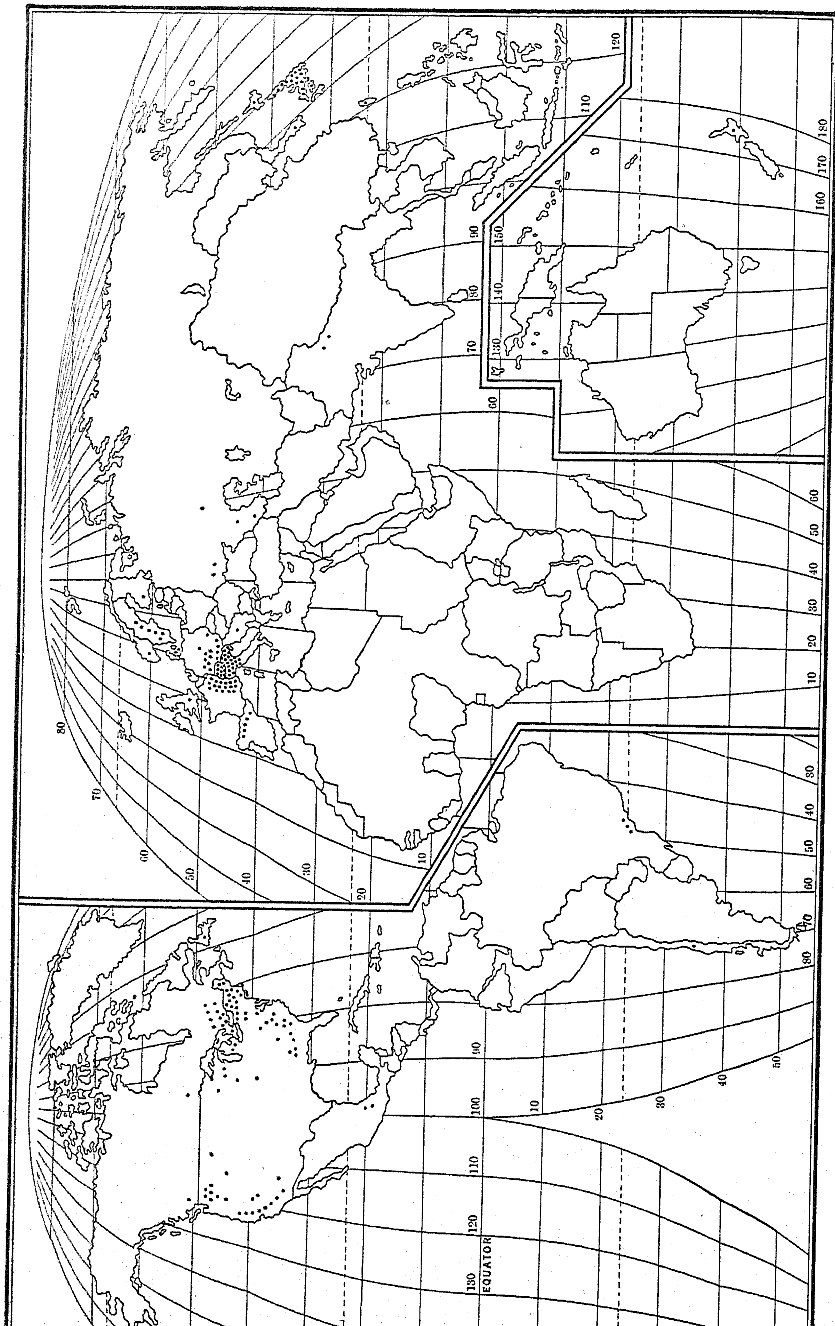
A—World Distribution of Horses.

due to the cyclonic climate. In cyclonic regions the people have plenty of work for horses and plenty of freight for railways, and they also have the ability and energy to improve the breeds of horses and to invent and build railways.

If we had space in this book for maps showing the world distribution of good roads, automobiles, trolley lines or airplanes, they would all show the same preeminence of the cyclonic regions. How true this is for automobiles is shown in A363.

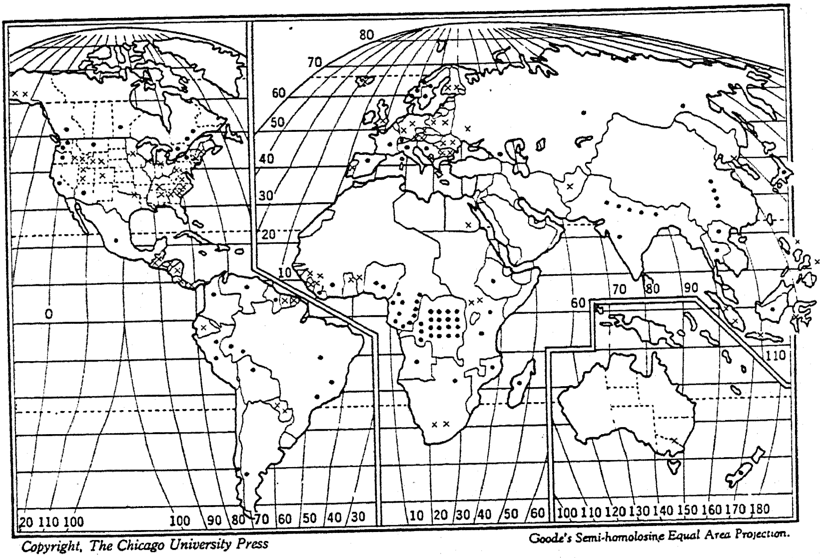
Where the World's Manufacturing Is Done

The Part Played by Sources of Power. If a country is to be prominent in manufacturing, it needs (1) iron for equipment, and (2) sources of power; but much the most important requisite is (3) inventive, energetic people to establish the factories and run the machinery. We have already



A—World Map of Developed Water Power, 1937-1939. Each dot indicates one-half of one per cent but fractions between one quarter and one half have also been indicated by dots.

seen that, though iron ore is found in practically all parts of the world, it is extensively mined and smelted only in cyclonic regions. Coal follows the same rule. Although coal is less abundant in tropical countries than elsewhere, it is found to some extent in all the climatic zones. Some of the finest deposits are in China and Indo-China. Yet almost all the mining is done in the cyclonic regions, as is clearly evident from A322. What little coal mining is carried on elsewhere, as in Spitzbergen, is often done in order to bring more coal to the cyclonic regions. As a rule, however, the amount of coal mining outside of cyclonic regions is so small that coal is



B—Potential Waterpower Available 90 Per Cent of the Time. Each dot indicates 1 per cent of *potential* power and hence represents about 10 times as much power as a dot in the map above.

carried in large quantities from the United States, and especially England, to remote parts of the earth such as China, even when those regions have supplies of their own which are not yet developed.

A similar situation prevails in respect to petroleum and water, the two other main sources of mechanical power. A330 shows that, although the United States is by far the greatest producer of petroleum, that fuel is by no means so highly concentrated in the cyclonic regions as is coal. Europe, in fact, has very little except in the southeast in Rumania and Russia. On the other hand, a constantly increasing supply is being found in South America and Asia. Thus it appears that the supplies in the United States have yielded large returns hitherto not so much because

of their abundance or ease of development as because the people were alert and advanced enough to utilize them.

Waterpower illustrates this same principle even more forcibly than coal or petroleum. A468 shows that most of the world's developed waterpower is in the United States and Western Europe. A469, on the other hand, indicates that the potential power, that is, the power that might be developed, is mainly in Africa and Asia. New England, where waterpower is often said to have been the cause of the early development of manufacturing, is not nearly so well supplied with waterpower as many other regions, such as Labrador and Finland, where manufacturing has not yet developed very far.

The Part Played by People. The true relation between manufacturing and sources of power may be summarized as follows: Before any sort of mechanical power was used, the art of manufacturing had reached its greatest development in the same regions where it is now most active, if we allow for the fact that areas like our Great Lakes district were not then inhabited by civilized people. Machinery was invented in the manufacturing regions because the people there were progressive and active. As soon as that happened these same qualities caused the people to hunt for sources of power. In England wood was first used, but soon gave place to coal. In New England waterpower was easily available and hence was widely utilized, whereas coal could not be brought cheaply enough till long afterward. Neither coal nor waterpower had anything to do with starting the use of machinery, but they increased its use enormously after it was once begun. The cyclonic regions, by mere accident, happen to have the best supplies of coal in the world. In the hands of energetic and progressive people this has greatly helped them to develop factories. They do not have any such outstanding position in respect to petroleum and still less as to waterpower. Nevertheless, they are as supreme in the use of these, as in the use of coal. Hence it appears that the quality of the people is much more important than the quality of their resources.

The energy and skill of the people, as we have seen, arise partly from a good biological inheritance, partly from the historic sequence of events which gave Europe the world's highest culture, and partly from the stimulating effect of the variable cyclonic climate.

With this in mind turn to A452, showing the percentage of the inhabitants who depend directly upon manufacturing in various regions. The darker the shading the greater the percentage. Notice that there are two prominent dark areas, one in the eastern United States, and the other in northwestern Europe. Each is in the heart of one of the world's two main cyclonic regions. Beyond their limits the amount of manufacturing rapidly diminishes, so that large parts of the map are only lightly shaded.

The only other places where the shading again becomes noticeable are a few smaller cyclonic areas such as Japan, southeastern Australia, and central Argentina.

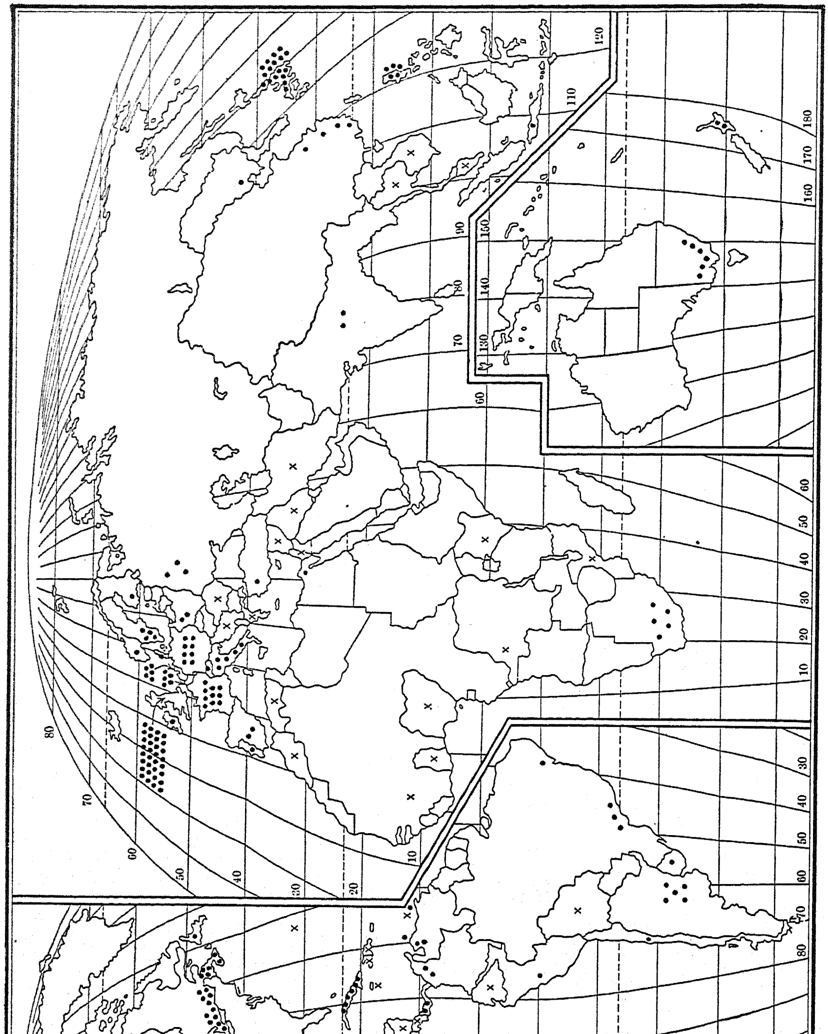
Why Cyclonic Countries Are the World's Chief Markets

Strange as it may seem, manufacturing countries buy from one another far more than from other climatic regions, and their sales are made in the same regions. England, for example, does ten or twelve times as much business with the United States as with three or four times as many people in China. Even with the 350 million people of its own chief colony in India it does only about as much business as with the 40 million people of France. The purchases and sales of the United States in foreign countries are shown in A472 and A473. If the trade of the United States with the 300 million people in the leading nations of cyclonic regions were cut off, two thirds of our commerce would be gone in spite of the fact that there would still be a billion and a half people with whom to trade. If it were not for our protective tariff our tendency to trade with the other progressive regions would be still more prominent. This is because the tariff shuts out foreign manufactured goods much more than tropical raw materials and foodstuffs, which do not compete with our own products.

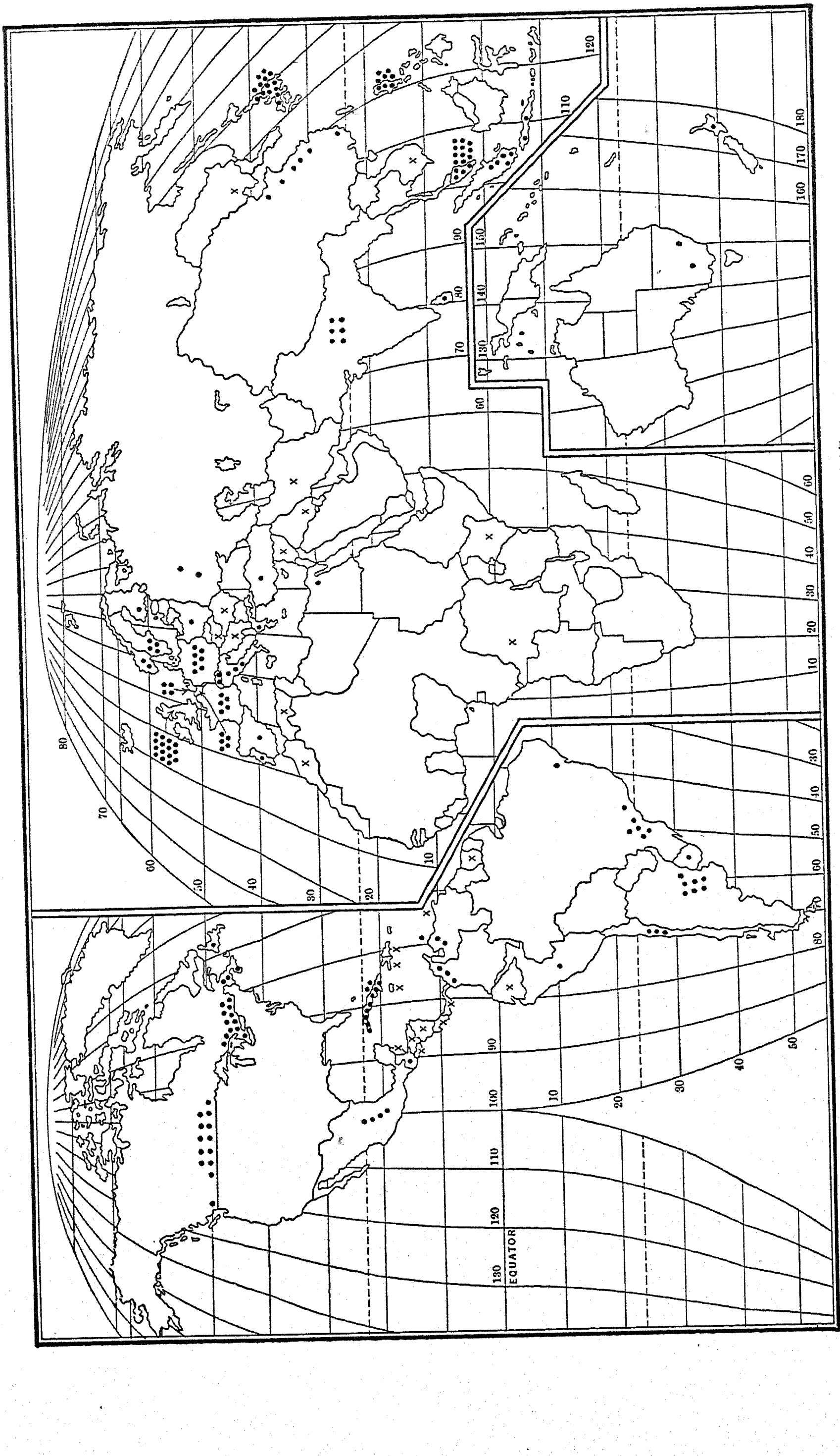
Business men continually urge the expansion of our trade with China, Russia, and especially Latin America. They are right in a way, for those countries, particularly the ones that are tropical, produce many useful products which our own country cannot furnish. It is more important for us as a nation to be able to purchase tropical rubber, quinine, coffee, and tin, which we cannot possibly produce in our own country, than to be able to buy European cloth, machinery, or dyes, which are not very different from our own, and which we might make ourselves, although at a higher cost. Yet in spite of this it is far more difficult to add a billion dollars to our trade with tropical America than to add the same sum to our trade with cyclonic Europe. The reason is largely the difference in energy. The tropical people do not exert themselves to produce goods that we want, nor do they earn enough to be able to buy large quantities of the goods that we make, no matter how attractive such goods may be. Hence most of the world's trade, as well as most of its other activity, centers in the cyclonic regions.

How the Cyclonic Regions Lead the World

The people of the cyclonic regions rank so far above those of other parts of the world that they are the natural leaders. We have seen that they excel the rest of the world in the number, quality, and productivity



A—Exports of the United States, 1936-37.
A round dot = ½ of 1%. x = less than ½ of 1% but more than 1/20 of 1%.



A—Average Imports into the United States, 1936-37.
● = ½ of 1%. x = 1/20 to ½ of 1%.

of their crops and domestic animals. They produce most of the metals, or else exploit them elsewhere and bring them home to use. They are similarly active in exploiting fuels and waterpower, thus helping to make themselves overwhelmingly predominant in manufacturing and commerce. Yet their greatest products are ideas and the institutions to which these give rise. The fundamental gift of the cyclonic regions is mental activity. For instance, the form of democratic government which was thought out in France and England, but which was first fully tried in the United States, is the form which most countries everywhere are gradually trying to adopt, in spite of the recent, but presumably temporary, growth of dictatorships. The constitutions of all the South American countries are directly modeled on that of the United States, and those of other countries have been influenced by it. Again the inventions of cyclonic regions, especially the United States and England, have led the way to the use of machinery, wherever the steam engine, telegraph, and such devices as the sewing machine have gone. So, too, scientific writings and literature composed in English, French, and German are translated into other languages and serve for instruction and models in every part of the world. In the same way the people of Asia look to Japan as the leader who is showing them how to put themselves on an equality with the countries inhabited by the white race. In art, music, philosophy, and other higher elements of civilization the energy of the cyclonic regions likewise makes them the leaders of the world.

QUESTIONS, EXERCISES, AND PROBLEMS

1. A. The *Abstract of the United States Census* gives a table of illiteracy among native whites. On an outline map of the United States insert the figures there given and draw smoothly curved lines, or isopleths, at intervals of 0.5, 1, 2, etc. Shade the map so that the best areas will be dark and the worst light. What kind of relation do you detect between your map and A65, A460, A565, A and B352, A and B353? Explain.

B. Draw a similar map of illiteracy among colored people, but change the percentages at which the isopleths are drawn. How far does this resemble the map of illiteracy among native whites? Why?

2. The table on page 475 shows the average annual deathrate in Europe. From the figures make a map in the same way as in the preceding exercise, drawing your lines at deathrates of 12, 14, 16, 18, and 20. Compare your map with A60, A64, A107, A144, A322, A352, A363, A455, A472, A473, and A568. Explain whatever relationships you detect, and state your conclusions as to the connection between health and each of the other conditions illustrated in these maps and in those mentioned in exercise 1.

3. Take one country from each of the groups mentioned below, and in the *Statesman's Yearbook*, the *U. S. Commerce Yearbook*, or the encyclopedia, find figures for its foreign trade: (*a*) Britain, France, Germany, Holland; (*b*) Rumania, Russia, Bulgaria, Egypt; (*c*) Thailand (Siam), Ecuador, Peru, Belgian Congo; (*d*) Argen-

RECENT ANNUAL DEATHRATES IN EUROPE

Old Austria	14	France	16	Norway	11
Belgium	13	Germany	11	Rumania	22
Bulgaria	17	Hungary	15	Russia	20
Denmark	11	Ireland	14	Spain	17
England	12	Italy	15	Sweden	12
Finland	15	Netherlands	10	Switzerland	12

tina, Chile, Union of South Africa, New Zealand. For each of the countries thus chosen draw maps like A472 and A473. Write an account of the more notable resemblances and differences among the four maps and of the geographical conditions which give rise to them.

4. For each of the world's chief products, as given in the table on page 449, write a list of two to five countries where the product in question is produced in especially large quantities in proportion to the population. Use commercial maps in geographies or atlases. On an outline map of the world print the name of the product in each of the countries where it is especially important. Count the number of names in each country, and arrange the countries of the world in order according to the number of names. Discuss the five countries that stand highest on your list, and give the geographical reasons for their position. In the same way discuss the five countries that stand lowest.

CHAPTER XXIV

MAN'S CHANGING SURROUNDINGS

Geographic Constants and Variables

Among the physical features of man's surroundings three, namely, the earth as a globe, land forms, and water bodies, may be regarded as constants. The location of a place in relation to the poles and the equator, or in relation to the lands and the oceans, never changes, or at least changes so slowly that man is not conscious of it. Land forms are almost equally constant. Although the mountains may be worn down a little by erosion in the course of hundreds of thousands of years, or raised a little higher by earth movements, they have not changed appreciably during the period covered by human history. With water bodies, the third element, the changes are equally unimportant except where variations of climate cause a desert lake, for instance, to dwindle in size, or a river like the Hwang Ho to become China's sorrow, or where man himself has built reservoirs, enlarged harbors, and reclaimed land from swamps or from the sea, as in Holland.

Soils and minerals, the next great features of man's physical surroundings, are more variable than the first three. Their changes are of two kinds, extremely slow ones due to nature, or rapid ones due to man. Slow changes consist of the weathering and aging of soil, the accumulation of humus, and the formation of new mineral deposits by igneous agencies or by water that percolates through the rocks. These changes, however, are almost as slow as the changes in relief, and hence play little part in human affairs. The changes caused by man are so rapid that they profoundly influence his destiny. By cultivating the soil he robs it of its wealth. In China thousands of square miles have lost their valuable cover of soil because this has been washed away after the cutting down of the forests. In some long-cultivated countries, such as Greece, the soil has suffered much from constant cultivation without the addition of proper fertilizers. In Italy, and other countries, such exhaustion of the soil probably helped to cause the fall of the Roman Empire. In Palestine one often sees great areas where slopes that were once wooded and covered with deep soil are now largely bare and rocky. Nevertheless, in large areas the soil is being steadily improved, as happens in modern market gardens. Mineral deposits are likewise exhausted by man. In

any mining country one can find towns such as Virginia City in Nevada, or Cobar in Australia, that once were prosperous but now have fallen to ruins because the earth has been pillaged of its mineral deposits. Practically all the changes wrought by man in mineral deposits are for the worse. When the earth has once been robbed of its metals, fuels, and rare earths, they cannot be replaced.

Climate, the last great feature of physical environment, is far more variable than any of the others. A rainy day spoils a baseball game or an automobile trip. A snowstorm ties up traffic and may cause many a small child to cry for milk. A cool, wet summer may cause an Adirondack resort to be almost deserted, and thus bankrupt the hotel keepers, cause the guides to go elsewhere for a living, and make the railroads and the boats on the lakes run at a loss. A drought of a few months may cause famines like those of India.

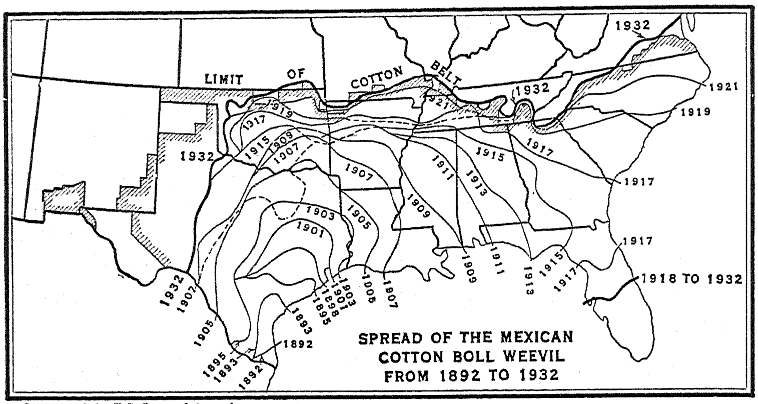
Often the climate grows wetter, colder, drier, or warmer, for a few years and then more or less promptly returns to the original condition. Such irregular climatic cycles vary from those of about 3 years, through those of about 11, 33, and 100, up to the great cycles known as glacial periods. Trees, foxes, grouse, and salmon are some of the many forms of life which show a cycle of about 10 years. At one stage of the cycles the big sequoia trees of California, for example, grow rapidly; at the opposite stage slowly. During the stages when animals are abundant, hunters and fishermen often think themselves very skillful because they procure much game and many fish. At the opposite stage they suppose that the presence of too many other hunters and fishermen has spoiled the sport. They do not realize that epidemic diseases often sweep off the animals by the million. In one way or another all these cycles, as well as those of the crops, seem to be connected with the weather. Thus, climate is the one great physical condition which by its very nature varies in such a way as to exert a tremendous influence upon man. The other five—the earth as a globe, land forms, water bodies, soil, and minerals—are relatively constant except when long periods are considered.

The plants and animals upon which man depends so largely are subject to quite as many variations as the climate. These often take the form of migrations, blights, and diseases. Let us begin with some of the variations in plants and animals and then pass to those more directly connected with man.

Examples of Geographic Variables

Insect Migrations. The migrations of insects illustrate the effect of geographic variables. The movements of the locust, for example, depend largely upon climate. In years when the eggs hatch in large numbers

vast swarms of the insects infest states such as Kansas. Having eaten every green thing where they were hatched, they migrate across the country by the million, leaving behind them a desert peopled by poverty-stricken and discouraged farmers. It is estimated that insects damage the cotton crop of the United States to the extent of $100,000,000 annually. Nearly half of this is due to a small gray beetle called the boll weevil. Since about 1890 the weevil has been slowly spreading from Mexico into the United States. (See A478.) It stings the flower buds in order to lay its eggs at the base of the young bolls or pods. This ruins the cotton. To get rid of the weevil the American farmers have tried many methods such as killing the weeds on which the insect lives during part of the year, introducing new and resistant varieties of cotton, such as that of



Courtesy of the U.S. Dept. of Agriculture

A—Migration of the Boll Weevil.

Guatemala, and poisoning the insects with calcium arsenate. Nevertheless, the boll weevil still persists, and has greatly reduced the area devoted to cotton in sections such as the Black Belt of Alabama. There cattle are often raised on rich black soil that once was devoted to cotton, but exhaustion of the soil has also played an important part in this.

How the Phylloxera Ruins the Grapes. The phylloxera, a kind of plant louse which ruins grapevines, has done even more damage than the boll weevil. Its original home is the United States, but there the vines have become immune to its attacks. About 1860, the phylloxera was accidentally introduced into Europe through the importation of American vines. It spread at once and did enormous damage. For instance, in 1865-7 the little commune of Graveson near Bordeaux in France obtained its ready money for taxes, clothing, and incidental expenses by producing 220,000 gallons of wine each year. In 1868 the phylloxera reached this section, and by 1873 the production of wine had fallen to 1,100 gallons.

By 1888 the total loss to France as a whole is estimated at 2 billion dollars. In some places the consequent poverty of the farmers led to violent political agitation, for people often have the strange idea that troubles due to geographical conditions can be remedied by changes in the laws. When once the phylloxera is introduced the only remedy is to root up all the vines and start with new ones raised from American stock.

Scales, Moths, and Other Pests. Many other insects, and also certain fungi, do similar damage. The San José scale, for instance, has almost ruined many orange groves. In the northeastern United States the gypsy, brown-tail, and other moths from Europe have greatly injured the trees. Massachusetts has spent millions of dollars in a single year to get rid of these pests and to eliminate insects that infest apples, peaches, and pears. The cornborer and the Japanese beetle are other highly undesirable recent immigrants. The only real remedy for many of these pests seems to be the introduction of parasitic contagious diseases which spread from insect to insect, or worm to worm. When the weather is warm and moist such diseases kill the insects by the million. Most of the insect pests themselves, as well as their parasites, thrive best in warm damp weather. This is one of the important reasons why agriculture is difficult and the yield of crops per acre is small in warm regions. It has much to do with the fact that practically all crops do best near their coldward margin. When warm, moist weather makes the insects breed rapidly, their numbers become so great that parasitic infections spread among them with extreme rapidity. Sometimes the insects almost disappear for a few years, as is known to everyone who has watched the tent caterpillar in wild cherry and apple trees. A late, cold spring which causes the eggs to hatch at the wrong time in relation to the leaves on which the insects feed has a similar effect.

Plant Migrations. The migrations of plants may be as harmful as those of animals. Sometimes a plant spreads because man changes the environment by destroying competing plants, providing great expanses of soil free from plants, or turning forest land into grassland or cropland. Sometimes man purposely or accidentally carries plants or their seeds from one area to another, just as he carries insects and their eggs.

The daisy, for instance, was introduced into America from Europe and then spread over millions of acres. It diminishes the hay crop by hundreds of thousands of tons, for it crowds out good grass, exhausts the soil, and is itself not eaten by any domestic animal. The Scotch thistle does similar harm. Even greater harm is done by small forms of yeast-like plants called parasitic fungi, which grow on other plants as mold grows on cheese. Among the worst of these are the wheat rust and the potato blight, which may ruin the crop in unusually wet seasons. In the

eastern United States the slowly spreading chestnut blight has ruined many a great tree like that under which stood the village blacksmith's shop in Longfellow's famous poem. The only known remedy is to cut down all the chestnut trees in a broad belt, as was done in Pennsylvania, so that the blight may have nothing upon which to live. Even then, however, new shoots often spring from the roots and live until the blight kills them. Then still other shoots spring up. In this way the blight has been known to be preserved at least 40 years after it first killed the chestnut trees.

Migrations of Disease. Men and animals as well as plants are often attacked by pests which spread from place to place and hence are variables. For instance, influenza is one of the most dangerous diseases because it is highly contagious, and even if its victims survive, they are weak for a long time. In this case, as in most variables, two factors are concerned: (1) micro-organisms which cause disease, and (2) man. The micro-organisms are present in most countries at all times. Occasionally, for reasons not yet understood, they suddenly become extremely virulent, and devastating epidemics occur. Man's variations are better understood. Under ideal conditions of climate, ventilation, and food, he may be able to resist the disease even in its worst form, provided his health is not impaired in other ways. In 1918 a terrible epidemic of influenza caused more deaths than any epidemic since the notorious Black Death of the fourteenth century. In the United States half a million people died either of influenza or of the pneumonia which often follows it. In the world as a whole about 15 million people, or nearly 1 in every 100, fell victims to the disease; in India the number was 6 million, or 1 in 50; in Mexico 1 in 25; in Yekaterinburg, a Russian city as large as Savannah, and now called Sverdlovsk, a third of the population perished, and in some Indian cities, half. The great ravages of influenza in tropical countries and also in regions such as Russia, where the people were especially weakened by war and famine, show that the greatest safeguard against the disease is a general condition of good health. The great mortality from influenza in the camps of our own army shows how the crowding of people into small areas favors the spread of infectious diseases. One of the most interesting facts about this epidemic is its relation to the weather. Why did some cities in the United States suffer severely and others not far away escape lightly? In order to answer this all sorts of conditions have been studied, such as density of population, age of the population, race, amount of manufacturing and crowding, and susceptibility to various diseases. The factor which shows an unmistakable relationship is the weather. Places where cool, pleasant autumn weather prevailed during the month before the epidemic usually escaped lightly.

Microscopic Creatures as Part of Man's Variable Environment. Since the microscope was invented people have learned the importance of tiny germs including both the minute animals called "protozoa," such as produce malaria, and the equally small plants called bacteria, such as spread typhoid fever. These tiny creatures are a part of man's geographic surroundings as much as the bigger forms of life such as horses, tigers, fish, and insects, or trees, bushes, grass, and corn. Because the protozoa and bacteria can be seen only under a powerful microscope, and are hardly known save by their results, they were long ignored. Their effects upon man, however, are fully as important as those of the larger forms of life, as is clear from the examples of diseases which we have just considered. Man must study the minuter forms of life with special care, because of their great variety and because they are so variable in their activity. He can plan to meet the attacks of tigers and wolves, but it is harder to meet the attacks of tiny creatures so small and numerous that we may take them in by the million at every breath, and so deadly sometimes that they kill a thousand men where wild animals kill only one.

Variation in Fisheries. Thus far in considering geographical variables we have concerned ourselves largely with pests. Let us now look at the movements of useful animals such as the fish of the Newfoundland Banks. More than half of the workers of Newfoundland are engaged in catching and curing fish. The total catch varies greatly from year to year because of changes in the fishes' food supply, in the amount of salt in the water, and in conditions of temperature, storminess, and winds. Hence the island sometimes enjoys prosperity and sometimes suffers distress. From about 1860 to 1868 the Newfoundland fisheries were so unproductive that widespread destitution prevailed among the working classes. Hence people began to turn to agriculture and stock raising, and farming received such a start that it has increased ever since, in spite of the cool climate. This is fortunate, for Newfoundland cannot prosper unless other resources beside fishing are exploited. A less favorable result was the introduction of a system of poor relief, not only for people who were unable to work, but for the able-bodied. This proved very demoralizing, for people said that, if the government would support them, they were not going to work. Even though the fisheries became successful again in 1869 the poor relief system had lasted long enough to do serious harm.

In New Brunswick a famous fishing club which owns a large area along the Restigouche River has for half a century or more kept careful records of the amount of time spent by its members in fishing there, and of the number and size of the salmon caught. The records show that the supply of fish goes up and down with remarkable regularity in a period

which averages a little less than ten years. Such cycles are like those which bring the famines that we have studied in China.

Weather as a Geographical Variable

Effect on Transportation. The direct effect of variations in the weather is more easily seen than indirect effects arising through insect pests, epidemics, or the migrations of fish. This is especially true of transportation. The 1,517 people who lost their lives on the *Titanic* owed their death to fog. In 1928 the British steamer *Vestris* sank in a gale off the coast of Virginia with 110 deaths. In 1935 the steamer *Dixie* with 231 passengers and a crew of 121 was blown onto the coast of Florida by a mighty gale. This was one of the few such misadventures in which no lives were lost. The ship was pulled off and put back into service. The records of shipping are full of less fortunate events where ships have disappeared at sea in stormy weather and never again been heard from.

Other types of transportation suffer similarly. A typical case is that of two trains which collided in a fog between Edinburgh and Glasgow in 1935 with the loss of 35 passengers. Thousands of trains are delayed every winter by frozen switches, snow, or ice. At other seasons trains are again and again put out of commission by floods. The same thing happens to automobiles. It is a common experience for millions of cars to find difficulty in traveling each winter. Frozen radiators, pistons scratched because the oil is frozen, icy roads, snow, or merely heavy rain all make difficulties. No one knows how many accidents, especially minor ones, are due to such causes, but they certainly cost tens of millions of dollars each year.

Transportation is even more subject to the vagaries of the weather when people travel in the air than when they travel on the water or the land. A famous aviator, Wiley Post, and a still more famous writer and comedian, Will Rogers, are two of many eminent persons who have died in aerial accidents. They lost their way and fell in a fog near the coast of Alaska. In 1937 an airplane bound from Cheyenne to Salt Lake City crashed against the Uinta Mountains in a snowstorm, and 19 persons were killed. That same year an airplane carrying members of a European royal family hit a factory chimney in a fog, and 11 people were killed. The use of huge, silvery dirigibles, which make such an imposing appearance in the sky, has been abandoned largely because accidents due to the weather are so common. One of the best-known dirigibles was torn to pieces in a thunderstorm. Another was hit by lightning; a third crashed against a wooded hill in a storm on its way to India. The chief of the American Aviation Service was drowned when one of the largest dirigibles, the *Akron,* was forced down in a storm off the New

Jersey coast. High winds, even without rain or snow, interfere greatly with aviation and are responsible for many accidents. Thousands of other examples of the effect of the weather on transportation could easily be gathered.

The more elaborate and delicate the machinery used in transportation, the more sensitive it is to the weather. A man on foot can travel on skis or snowshoes where no other form of transportation is feasible. A horseman can ford flooded streams or wade through mud that would prevent carts from traveling. Trains are stopped by the weather more frequently than are horse-drawn vehicles. Where such vehicles are used, runners can be substituted for wheels in snowy weather. Sleighs or sledges are one of the most efficient ways of using animals for transportation. Automobiles are kept off the roads by bad weather more often than are trains. Airplanes, and especially dirigibles, are more subject to the caprices of the weather than any other common forms of transportation.

Impressive Types of Climatic Disasters

So great is the effect of climatic variations upon human prosperity that we may well consider some of the more impressive types. Tornadoes are one of the most spectacular and dangerous manifestations of weather. It is an awe-inspiring sight to see a black, whirling funnel sweeping toward one, while an ominous black cloud spreads out at its top. Tornadoes are most common in the south-central part of the United States. The early part of February, 1884, was a famous tornado season. In the region from Illinois to the Gulf of Mexico and as far east as Virginia tornado after tornado occurred. Over 800 people were killed and 10,000 buildings destroyed. Lightning in ordinary thunderstorms sometimes does terrible damage. In 1926 a munition reservation of the United States Navy in New Jersey was struck by lightning. The explosions and fires which resulted from this killed 21 people, destroyed 80 buildings, and did damage to the extent of $85,000,000. A considerable percentage of the fires in the United States and other countries is due to lightning.

Floods are another ominous result of unusual weather. We have already seen what dire effects they produce in China. In 1911 a Chinese flood drowned about 100,000 people. This takes no account of the still greater number who died later because the flood ruined the crops and led to famine and disease. For about six weeks in April and May, 1927, our own Mississippi inundated 20,000 square miles of land along its course from Missouri and Kentucky southward. Over 4,000,000 acres of crops were destroyed, together with 25,000 horses, 50,000 cattle, 148,000 hogs, and 1,300,000 hens and other poultry. Several hundred people were drowned

and 600,000 rendered homeless. The property damage amounted to \$270,000,000. Nevertheless, this was a small flood compared with those which frequently occur in China.

The severity of this Mississippi flood was due in part to a great number of thunderstorms and tornadoes which killed nearly 300 people. They occurred mainly in states west of the Mississippi River, all the way from Wyoming to Texas. Such minor storms are common on the southern or southeastern flank of larger cyclonic storms. They are especially common in cases such as this when rain falls day after day over a large area. Such steady and prolonged rains occur when a tropical air mass remains almost stationary day after day, instead of moving forward toward the east in the usual fashion. The great Mississippi flood of 1927 owed much of its water to such an air mass, which hung for weeks over a large part of the Mississippi drainage area and was constantly replenished from the Gulf of Mexico and the Atlantic Ocean.

In January, 1937, another tropical air mass remained stationary in the same way over the lower Ohio Valley, giving the Cincinnati region far more rain in January and early February than had ever been known before in so short a time. As a result 500,000 homes and vast areas of farmlands were flooded. Over 900 people were killed, of whom 35 were rescue workers who were drowned when a steel barge was sunk. When the flood subsided many houses were complete wrecks; others had floated away and were standing far downstream on other people's land. Among those which stayed where they belonged many were in an almost hopeless mess, with inches of mud covering the floors, filling the dishes in the cupboard, and ruining the piano. Wallpaper hung loose where it had been soaked off, and bedding and furniture were stained and ruined.

Hurricanes. The most spectacular results of changes in the weather are due to hurricanes. In September, 1900, Galveston, Texas, was visited by a hurricane from the West Indies. A violent wind blew for 18 hours, reaching a maximum velocity of 84 miles an hour. The waters of the Gulf of Mexico were piled up in enormous waves that swept across a large part of the city, destroying or badly damaging more than 8,000 buildings, and entailing the loss of about 6,000 lives and of property valued at \$30,000,000. Thereupon the city set to work to prepare for the recurrence of this variable geographic condition. A wall of solid masonry was built for 5 miles along the water front at an expense of \$2,000,000. The entire grade of the city was raised from 1 to 15 feet above its former level.

In August, 1915, there came another hurricane nearly as dangerous as that of 1900. The maximum velocity of the wind was 93 miles per hour, but the tide at the highest rose only 12 feet instead of 20 as in 1900. Thanks to the seawall and to the warnings sent by the Weather Bureau

to people living beyond the protection of the wall the loss of life in 1915 was only about 275, and the property loss was much less than before. Many other regions on the borders of the tropics have had similar experiences with hurricanes. Miami, Florida, in 1926, suffered from one rivaling that of Galveston. Cuba, Puerto Rico, the Philippines, and southern Japan are other regions that suffer in this way. Here are some figures for especially destructive hurricanes since 1925:

Year	Month	Place	Persons Killed	Persons Injured	Damage, Millions of Dollars	Houses Ruined	Homeless Families
1926	Sept.	Florida, Ala., Miss....	399	6,281	...	5,000	17,884
1926	Oct.	Cuba................	40	.....	...	.....	......
1928	Sept.	West Indies, Florida..	3,000	.....	107	.....	......
1930	Sept.	Santo Domingo.......	2,000	6,000	40	.....	......
1932	Sept.	Puerto Rico, Virgin Is.	260	3,329	30	36,000	41,000
1934	Sept.	Japan..............	4,232	.....	90	.....	......
1935	Sept.	Florida.............	300	.....	......	.....	......
1935	Oct.	Haiti...............	2,000	.....	......	.....	......

All but two of these eight fierce hurricanes occurred in September, and the other two in October. Such dates are characteristic. In the northern hemisphere practically no hurricanes occur from about the middle of September until the middle of May. Five of the eight did their work within the tropics: two occurred in Florida between 25° and 30° from the equator, and one in Japan, 30° to 35° from it. These figures, too, are characteristic. Hurricanes belong primarily to latitudes between 10° and 25°, where they always move toward the west. Many, however, swing to the north and then to the northeast as they approach the east side of a continent. There they may proceed as far as latitude 40° or more. Generally they remain over the ocean near the coast. For this reason Japan gets many typhoons, as they are called there.

The east coast of the continents themselves are not wholly safe from hurricanes, even in fairly high latitudes. On September 21, 1938, a hurricane swept up the Atlantic past North Carolina at an extraordinary rate of speed, and struck Long Island squarely in the middle. It rushed on at the rate of 60 miles an hour, its center passing near New Haven and then Springfield. Wherever it struck it did great damage, especially on its eastern side where the wind sometimes blew at the rate of more than 100 miles an hour. Along the coast it piled up the ocean water to a height of 10 or even 15 feet above normal high tide. On the low, sandy beaches and bars, which are common along the coast of southern New England

and Long Island, it swept away thousands of houses. In some places a row of as many as 50 houses disappeared completely except for a few chimneys and concrete garage floors. In some such cases the houses, with their lower stories shattered, actually floated across lagoons and were stranded high and dry on the inner shore half a mile or more away. Elsewhere houses were turned on their sides. The lower stories of others were swept away leaving the upper stories standing on stilts. Elsewhere the boards of one house were packed away in chaos inside the lower story of another. Boats were swept hundreds of feet inland; some of them were deposited in streets, or in people's back yards.

Farther inland many barns and houses were blown down, and hundreds of thousands of trees were laid low. In some places acres of trees were toppled over, though neighboring trees were uninjured. Miles away from the sea the trees were coated with seawater. This fostered the growth of a fungus which gave a brown color to the leaves still left on the trees. The loss of life is estimated at 682. It would have been vastly more if the hurricane had occurred a month earlier when most of the summer houses along the shore were occupied. The damage to property is estimated at $400,000,000, which is far more than in any other hurricane. Never before has such a hurricane passed through so densely populated a region where so many houses stood close to the sea.

One of the strangest effects of the hurricane was seen at Massachusetts State College at Amherst. There the freshman class customarily takes three intelligence tests on three successive days. In their first test, the day before the hurricane, the class averaged 4 per cent higher than the average for previous classes, but this is no more than often happens by accident. The third test was postponed till the second day after the hurricane because on the day when it would normally have come the students were busy helping to remove trees from the street, and to get things shipshape after the storm. In this test the class averaged 10 per cent below the average of the two previous classes which took the same test. The excitement and weariness of the preceding day were doubtless responsible for this.

The remarkable part of the matter was what happened in the second test. The students went into the examination room while the hurricane was raging, and were writing while it was at its height. The wind was howling, trees were crashing to the ground outside, and the room became so dark that the lights had to be turned on. When the examination was a little more than half finished, a falling tree carried away the electric-light wires. The examination had to be finished in a room so dark that the students could hardly read. Nevertheless their average rank was amazingly high. Ordinarily Massachusetts State College ranks in about

the 75th percentile among nearly 400 colleges where this same examination is taken by the freshmen. In other words, about 75 per cent of the colleges rank below it, and 25 per cent above. In 1938, however, Massachusetts State College rose to the 95th percentile, far higher than ever before.

Some people think that this happened because the mere excitement of the hurricane stimulated the students so much that they did wonderfully good work in spite of the noise and the bad light. Others believe that the noise, the excitement, and the bad light would have made the students do poor work unless some other stimulus had been present. They suspect that this stimulus arose from a rapid, but brief, increase in atmospheric ozone. Ozone is oxygen with three atoms in each molecule instead of two. It is a very powerful oxidizing agent. If more than 1 part of ozone is present in 10 million parts of air for any great length of time, it is dangerous. One part in about 20 to 60 million, however, gives a pleasant stimulating effect.

Two professors of chemistry at Massachusetts State College noticed that at the end of the hurricane, an hour or two after the close of the examination, the outdoor air had become so charged with ozone that it could be smelled. This means a large enough amount to be dangerous if it continues long. While the examination was going on, however, there was not enough to smell, but it was evidently increasing rapidly. These conditions were such as would normally be expected in so extreme a storm. Cyclonic storms in middle latitudes are regularly accompanied by changes in the amount of atmospheric ozone. Before a storm, at the time when a tropical air mass is arriving and the air has the deadening, enervating effect which we often associate with the period before a storm, there is little or no atmospheric ozone. While a storm is in progress the amount increases, reaching a maximum when the arrival of a cool, dry polar air brings the storm to its final stage. Such facts and many others have led to the hypothesis that the stimulating effect of cyclonic storms, which we have discussed in earlier chapters, is due in part to the repeated arrival of waves of atmospheric ozone. How true this may be no one yet knows. Tropical regions receive no stimulus of this kind, and it is rare in regions such as Central Asia.

Weather and Agriculture

The effect of variations in the weather upon agriculture is so great and so widespread that every intelligent person knows something about it. It has been mentioned again and again in this book in connection with floods, droughts, delayed monsoons, and various other conditions. A good example of one phase of such variations was seen in the final two

decades of the last century in Florida. At that time a succession of unusually severe frosts drove the orange industry out of northern Florida. Since then orange growing has been restricted to the south. In the other great American orange region, southern California, the danger of frost involves large expense for smudge pots. On clear, still nights when the danger of frost causes orange growers to set the oil on fire, many square miles outside of Los Angeles are shrouded in thick, oily smoke. This is unpleasant to breathe, and it plays havoc with curtains and other fabrics, but it saves much money by preventing the orange groves from cooling off too much at night. In many other regions frosts that occur unusually late in the spring, or early in the fall, do millions of dollars' worth of damage to all sorts of crops, including peaches, early vegetables, corn, and many others. Such fluctuations in weather are one of the greatest hazards of farming.

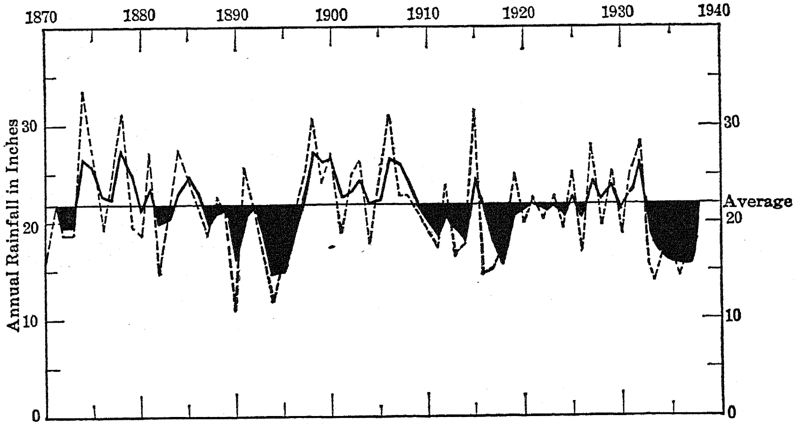
Fluctuations in Rainfall. Variations in rainfall from one year to another are especially important. In western Kansas, for example, the corn crop is very sensitive to the rainfall, for this region is near the dry limit beyond which corn will not grow. A489 shows the fluctuations in rainfall that have affected the farmers of western Kansas since 1870. When the curved line is above the straight line representing the average rainfall the farmers prosper. When it falls below, they often cannot raise enough to support their families and pay their debts.

The meager rainfall of the early seventies did little harm, for then there were few settlers in western Kansas, and most of them depended upon cattle more than on crops. Even among these, however, some became so poor that they had to move away. The period from 1874 to 1886 was excellent on the whole, for the rainfall was generally abundant. Settlers moved into western Kansas in considerable numbers. Each farmer received from the government a "quarter section," that is, a quarter of a square mile of land, 160 acres. For a few years everyone was enthusiastic, and the land available for settlement was rapidly taken up.

Then came a period of scanty rainfall lasting till about 1896. Thus the climate and the crops completed a cycle. Dry conditions returned just as the summer returns in the shorter cycle of the year. Year after year the rainfall was scanty and the crops were poor. The farmers were able to struggle along only by mortgaging their houses and getting more and more into debt. At last, with no improvement in rainfall, conditions became so bad that farms were abandoned by the hundred. Many families were too poor to pay railroad fares. They packed up all their belongings in great farm wagons, and drove away seeking new homes. During this low period in the cycle of rainfall not only did the farmers themselves suffer, but also the merchants who supplied their wants, the people back

in the East who had lent them money, the manufacturers who made the goods that they consumed, and the railroads that usually carried the crops that they raised. When a renewal of good rainfall once more made farming profitable, the abandoned farms were reoccupied. The scanty rainfall of 1910 to 1920, however, brought back the old trouble. It would have had much worse effects if the World War had not brought high prices for farm products, and plenty of opportunity for farmers to find work elsewhere.

How Dry Farming Helps in Regions of Scanty Rainfall. During these repeated dry periods the farmers of Kansas and neighboring states developed a new method of providing against drought. They learned a way



A—Rainfall in Western Kansas during the Agricultural Year, October to September. The dotted line shows the actual rainfall at two stations, Hays and Dodge. The solid line shows the effect on the farmer if we assume that his prosperity depends not only on the present year, but on the preceding year, reckoned as two thirds as important as the current year, and on the year before that, reckoned as one third as important.

of preserving the water in the soil for many months, or even from one year to another. They do this by plowing or harrowing after every rainy season, thus killing the weeds which would otherwise suck the moisture out of the soil and give it to the air. The harrowing also breaks up the crust that forms when the soil dries and causes the surface to be covered with a layer of soft, dry dust. This acts like a blanket and helps to prevent the ground water from evaporating. This method of "dry farming" enables the rain of two or three seasons to be largely retained in the soil, and thus makes it possible to grow crops with comparatively little rainfall. It is a great help to the farmer, but demands a large amount of labor. Russia practices dry farming on its huge state farms north of the Caspian Sea. It was able to find great areas there with comparatively few inhabi-

tants because the climate is so dry that farming is profitable only when huge machines which were invented in America make it possible to plow the land cheaply and frequently.

The Great Drought and the Dust Bowl

Dry farming, like most good things, has its dangers and can be carried too far. The farmers of the entire belt from western North Dakota southward to western Texas found this out to their sorrow in 1934 and later years. In A489 the last part is the worst. After 1933 the rainfall of western Kansas, as well as that of neighboring regions, sank to about 25 per cent below the average and remained at about that level for five years. It rose to about the average in 1938, but fell off again in 1939. Never before, since the white man began to keep records, had the weather presented the western plains with so long a period of scanty rain and rain at the wrong seasons. In May, 1934, the United States, even in its eastern parts, began to become conscious of dust storms. The rainfall in preceding months had been so scanty that the winter wheat of the drier western part of the Great Plains had made little growth, and many dry farming fields were unplanted. As the drought grew more intense, strong winds began to blow, as is common in continental interiors under such conditions. The wind picked up the dust from the dry, powdery, unplanted fields, and even to a considerable extent from the planted fields where the crop was too scanty to hold it.

When such a wind blew with full violence, the effect was like that of the famous "sand storms" of deserts such as the Sahara and central Australia. The air was so thick with dust that automobiles had to drive with lights even at midday, and could not see other cars until they were only one or two hundred feet away. The light parts of the soil were blown high in the air, and the finest parts were carried so far that the air in eastern cities became hazy. Most of the soil, of course, was deposited within a few miles of its origin. In some places several inches of the rich topsoil were stripped from the fields, thus greatly injuring them for future use. The heavier, sandy parts were driven along the ground and sometimes piled into sand dunes which rose higher than the fences. Occasionally a shed or house was partly filled with drifting sand. More serious than this, however, was the way in which sand was sometimes piled on top of the good soil of fields which the wind had not yet eroded.

The result of all this was tragic. Hundreds of thousands of families were reduced to poverty. Their crops failed completely, or else to such a degree that the families did not have money enough to supply food for themselves and feed for their animals. Of course there were no farm

products to sell, and hence no money for taxes, interest on mortgages, doctor's bills, clothing, or even the food and feed necessary to keep themselves and their animals alive. Many families were forced to abandon their farms. Many of them had to let the ownership pass into the hands of persons, banks, or insurance companies to whom the farms were mortgaged. Some such families came to the East. Many migrated to California, where they thought that irrigation insured prosperity and would protect them against future droughts. So many came, however, that California could not receive them all, and did everything possible to stop them, even stationing police to prevent them from entering the state.

The region that was hit hardest of all has a diameter of 300 miles more or less, and lies irregularly around the "panhandle" of Oklahoma in that state and in parts of Kansas, Colorado, Texas, and New Mexico. So much dust was blown from here that the area has since been called the Dust Bowl.

Although the drought did its worst damage in the western part of the Great Plains, the farmers in all the states as far east as the Mississippi River and even beyond suffered more or less. The industrial East suffered from the drought in a different way. Hundreds of millions of dollars' worth of mortgages on western farms were held by eastern banks, insurance companies, and individuals. These became practically a dead loss. Business in eastern industrial regions, which was already bad, suffered a further setback because the western market became so poor. Then, too, the whole country had to pay unusually heavy taxes because the Federal Government was forced to take care of the drought-stricken farmers. The job was too big for the individual states. Food and feed had to be provided. Great numbers of cattle, for which no feed was available except at great expense, were bought and slaughtered by the government. Provision was made for financing many mortgages at public expense. Thus the last dry period of A489 was the worst.

All this teaches many geographical lessons. It shows that even where weather records have been kept a long time there is no guarantee that there will be no extremes greater than have yet been experienced. It shows also that there are large sections of the United States, as well as of other countries, where agriculture is practicable in years of good weather, but cannot be relied on. If people hope to maintain high standards of living, evidently they must not attempt to farm such regions. Apparently, if the drier plains west of the prairies are to be used, they should be devoted mainly to stock raising, with crops as only a secondary reliance. The mode of life and the occupations must conform to the geographical environment.

Variations in Rainfall and Migration from Western Europe

The migration of Europeans from the Old World to the New is another important historical event that has been greatly influenced by fluctuations in the weather. The fundamental cause of such migration is, of course, the fact that America is a new land with abundant opportunities, while Europe is an old land densely populated. These conditions are a *constant* impetus to migration, and if acting alone would give rise to a steady flow of people into the United States. Other *variable* factors, however, enter into the problem from year to year. Since 1914, the World Wars and the restrictions imposed by the United States have been the chief factors in controlling migration, but previously changes in rainfall cycles vied with political and social disturbances as a cause of variations in the number of immigrants. Too much rainfall in Scandinavia, Britain, the Netherlands, and Germany may be as bad as too little in Kansas. Those countries are so far north and are usually so well supplied with rain that when the rainfall is above the average, and the summers are cool, vegetation does not get enough sun and warmth. Hence the crops are scanty; poverty and discontent arise; people want to get away to another country; and there is much emigration. The United States lies so much farther south than northwestern Europe that on the whole it is benefited by abundant rainfall. Hence prosperity is likely to prevail here when poverty prevails there, provided the rainfall cycles are the same in the two places, which often happens. Thus good conditions here may attract people from Europe just when poor conditions there are driving them away.

How Too Much Rain Brought the Irish to America. The European region that has been most affected by emigration to America is Ireland. Through emigration the population of that country has been reduced by half. At the census of 1841 there were 8,200,000 people, and in 1911 only 4,400,000. As in many other cases the emigration from Ireland is due to a constant cause which is within human control, and a variable geographical cause which is beyond it. The constant cause is the unfavorable social conditions. For instance, much of the land was till recently owned by a few absentee landlords who did not often visit their estates, and who cared little for the poor tenants provided the rent was paid. The variable cause is the fluctuations in the rainfall, and hence in the potato crop, which was long the chief agricultural resource of Ireland, before dairying rose to its present importance.

Previous to about 1845 Ireland enjoyed a comparatively dry period with excellent crops most of the time. The population increased until in 1845 it reached a maximum of 8,300,000. Then came a series of damp years which fostered a kind of potato disease so virulent that it produced

an almost complete failure of the potato crop. As a result 200,000 to 300,000 people died of starvation and fever. The British government provided work for over 700,000 people at one time, but this was not enough. Then food was distributed in enormous quantities, and over 3 million people were at one period supplied with rations. Nevertheless such great discontent arose that in 1848 a rebellion was attempted.

Perhaps the most important result of the excess of rain was a rapid emigration to America beginning in 1846. In five years the population diminished to 6,600,000—a loss of 20 per cent. During the succeeding dry favorable period the rate of emigration declined rapidly. In the eighties, however, another prolonged wet period with poor harvests made the bad social conditions still worse, and the people again flocked to America. Had the climate of Ireland been less variable, the important Irish element in the United States would still be here because of the constant cause of emigration found in social and economic conditions, but it would presumably be much smaller than it actually is.

How Rainfall Cycles Affect the American Farmer. Too much rain and too little are both harmful, but in the United States more harm comes from too little than from too much. Corn illustrates this. The corn produced in the United States is worth 2 or 3 billion dollars each year, or about as much as all the ores, metals, and other mineral products except fuels, but including iron, copper, gold, cement, and many other less valuable products. Its variations from year to year, however, are very great. For instance, in 1894 about 1,200 million bushels were raised, while in 1895 the crop was a billion bushels larger. There was a similar difference between 1901 and 1902, while since 1870 there have been at least a dozen times when the crop of one year has differed from that of the next by at least 500 million bushels. Luckily for the farmer the price is usually high when the crop is small. Nevertheless the farmer's receipts vary enormously. For example, in 1912 the average Kansas farmer received only about $90 for his corn crop; in 1913 he received $480. In 1910 the average farmer in North Dakota received $460 for his wheat, which was practically his only large crop, and in 1911 over three times as much, or $1,470. Even if we take all crops and all parts of the country we find that the average farmer raised crops worth $899 per 100 acres in 1899, $1,176 in 1891, and only $794 in 1896. Since the first World War similar variations have occurred. The prices received for farm products, to be sure, have been greatly influenced not only by climatic fluctuations, but also by the changes arising from the use of machinery, the depression and unemployment that began in 1930, and changes in the value of money. Here, however, we restrict ourselves to examples in which climate has been the chief variable.

The main factor in such climatic variations is rainfall. Corn can get along with a small supply of moisture during the early and late parts of its life, but from the end of June to early August, when the ears are developing, plenty of water is essential. The great corn-producing states of Ohio, Indiana, Illinois, Iowa, Missouri, Nebraska, Kansas, and Oklahoma, with the corn-growing parts of the neighboring states, plant 80 to 90 million acres of corn each year. If the July rainfall of this area averages about 2½ inches in one year and 3½ in another the difference in the yield of corn is about 6½ bushels per acre, or the huge amount of more than half a billion bushels. Another inch of rain adds nearly half as much more. It scarcely seems credible that a single inch of rain can produce such tremendous results, even though it covers such a large area. Surely rainfall is a geographic variable of almost unlimited power.

Luckily the whole country never suffers from deficient rainfall at one time. Yet in years such as the early nineties and in 1934 the deficiency was very widespread. In 1896 the average income of all the farmers in the country fell to only two thirds of its level in 1891. In 1930, 1934, and 1936 even more widespread drought occurred, bringing distress to practically the whole interior of the United States. Not only did many of the crops fail, but also the smaller streams in some places dried up and water supplies gave out. Forage for animals was also ruined so that many cattle died of hunger. In addition to many million dollars given through the Red Cross, Congress appropriated hundreds of millions of dollars for relief of the farmer, and gave far larger sums to provide work on public enterprises.

Under normal economic conditions, if the number of farmers is right in proportion to the needs of the rest of the population, abundant and well-distributed rainfall has a great effect on prosperity in general. Not only do the farmers prosper, but also the railroads receive far larger sums than usual for freight on the abundant crops and on the goods that are bought in exchange for them. The merchants prosper, for many more shoes, hats, suits, dresses, plows, clocks, knives, automobiles, and all sorts of manufactured goods are bought by the farmers in the good years than in the bad. Many factories also prosper, for since the farmers buy more goods than usual, the factories run on full time. Thus few people are out of work, and the manufacturing people as well as the farmers have more than the ordinary amount of money to spend. Newspapers and magazines are bought more frequently than at other times, moving pictures and other amusements are patronized with greater freedom. Moreover, many farmers who have been in debt are able to pay off their mortgages so that capital is available for new enterprises. The whole country feels a wave of prosperity, which shows itself not only in business, but also in quiet

political conditions, in great gifts for universities, hospitals, and other public institutions, and in a general feeling of satisfaction and encouragement.

QUESTIONS, EXERCISES, AND PROBLEMS

1. In any volume of the *Mortality Statistics* issued by the United States Census Bureau, look up the table headed "Deaths by Months of Occurrence." Plot the monthly number of deaths for the following places, beginning and ending each curve with January: (*a*) California; (*b*) Minnesota; (*c*) Maine; (*d*) Missouri; (*e*) North Carolina; (*f*) Alabama; (*g*) your own state or city. (These diagrams will be much more accurate and instructive if the numbers given in the table are first divided by the number of days in the month, and the results are again divided by the number of inhabitants reckoned in hundreds of thousands. This will give the number of deaths per day for each hundred thousand people, and the resulting curves can be compared without the necessity of making allowances for the number of days in the month and the number of inhabitants.) Interpret each curve as follows: (1) Which seasons are best and worst, respectively, and how much do they differ in percentages? (2) What effect is produced by the onset of warm weather? By the continuance of such weather? (3) The same for cold weather. (4) Sum up the effect of the changes of the seasons in each place, and show where the effect is greatest. Be sure to make full allowance for the number of inhabitants, for otherwise a small state or city will invariably appear more healthful than a large one.

2. Discuss A478, as an illustration of a geographic variable.

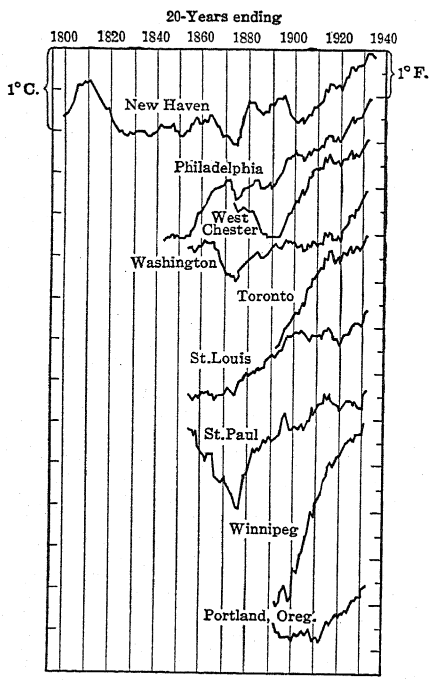
3. Describe in detail some variable geographic factor with which you are familiar, and discuss its effect.

CHAPTER XXV

CLIMATE AND HISTORY

Modern Climatic Pulsations

(1) *Temperature.* Variations in the weather from year to year tend to continue in the same direction for long periods. This is evident in A496, which illustrates several temperature records in the United States, including the one for New Haven, Conn., which is the longest in the New World. In order to avoid confusion because of brief variations from year to year, 20-year averages have been used according to the method of J. B. Kincer. Thus the first point on the left of the New Haven curve represents the average temperature from 1780 to 1799, and is placed under the date 1799. The next represents the 20 years from 1781 to 1800, and so on. The most significant fact about the diagram is that all the curves show an upward tendency in recent decades. At Philadelphia the temperature has been slowly rising for almost a century. Almost the same thing is true at New Haven and St. Louis. Such facts indicate pulsations of temperature lasting a century more or less. At New Haven the coldest long period was the 19 years from 1855 to 1873; the warmest period was from 1921 to 1939. Old people are evidently right when they say that in their childhood the winters were colder than now and there was more snow.

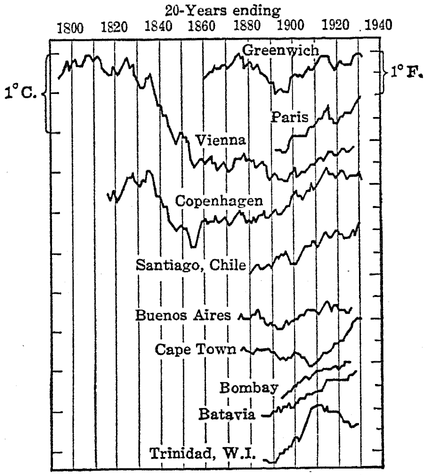


A—Pulsations of Temperature in Modern North America.

This same sort of change has taken place in Europe. At Stockholm, for example, the January temperature has risen fairly steadily since about

A.D. 1800. During this time the summer temperatures have become slightly lower, but the rise in winter has been greater than the lowering in summer. The mean annual temperature has risen gradually since about 1820. Farther south the change diminishes so that in southwestern France there was no appreciable change. In the western Mediterranean an opposite change has occurred, and the temperature is slightly lower now than formerly.

Other parts of the world show similar conditions with a general, although not universal, tendency toward higher temperature in the present century, especially in high latitudes. The retreating fronts of glaciers indicate the same thing.

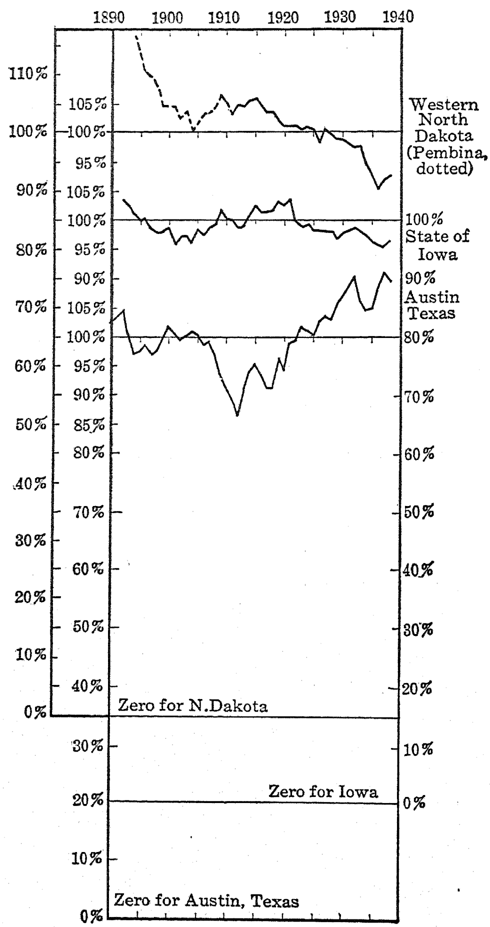


A—Modern Variations in Temperature outside the United States.

The significance of this recent change of temperature may be judged from the degree of change in geographical position that would be needed to produce it. At New Haven, for example, the coldest 20-year period averaged 2.7° colder than the period from 1920 to 1939. In order to produce so great a change in mean temperature it would be necessary to move New Haven southward as far as Atlantic City, that is, to a point 130 miles, or nearly 2° of latitude, south of its present location. In winter, however, the difference is greater, for the temperature of the three winter months (December through February) since 1920 has been 3.7° higher than in the earlier period whereas the summer (June through August) has been only about 1° warmer. At Philadelphia the increase in mean temperature between the 20 years 1825-1844, and the 20 years from 1919 to 1938, amounts to 5.8°, which is practically the same as if Philadelphia had been moved southward to Raleigh, S. C. A little of this change may be due to the growth of the city and the warmth sent forth by the fires in the houses. Most of it, however, is not due to this, for rural places where no such effect could be produced also show increasing temperature. Any one who leaves New Haven in the spring when the buds are beginning to swell and goes at once to Atlantic City where the leaves are well out realizes how much difference there is in the two climates. A similar trip from Philadelphia to Raleigh shows a still greater change. It is

clear that long fluctuations of climate lasting not merely scores but presumably hundreds of years from one high point to the next are taking place widely.

(2) *Modern Pulsations of Precipitation.* If we eliminate variations from year to year by using long-term averages, it becomes clear that rainfall, as well as temperature, may change in one direction for a long time. The upper curve of A498 shows that in North Dakota the rainfall has been declining more or less steadily ever since records have been kept. In Kansas, the middle curve, there have been fluctuations, but no marked trend in either direction. Still farther south in Texas an opposite condition prevails; the rainfall has been increasing since the 20-year period 1893 to 1912. The change of temperature during recent decades, however, has been upward in all three of these portions of the Great Plains, just as at New Haven. An increase in temperature can evidently be accompanied by either an increase or a decrease in precipitation. How nearly these changes have reached their limits and are ready to turn in the opposite direction is one of the most puzzling problems of climatology and geography. If the climate of New Haven should begin now to go back to its old condition at the rate at which it has been growing warmer, it would not reach the condition of 1856 to 1875 till after A.D. 2000. This would mean a cycle, or pulsation, with a length of 130 years or more. The Philadelphia curve of A496 suggests a still longer pulsation.



A—Variations in Precipitation in the Great Plains.

Ancient Climatic Cycles

There is abundant evidence that cycles such as this, but of longer duration and greater intensity, have taken place in the past. The greatest of these were glacial epochs. At such times a cool, and probably very stormy climate caused millions of square miles of North America and Europe, as well as the higher mountains elsewhere, to be shrouded in vast sheets of ice for thousands of years. During the 10,000 years more or less since the ice melted back almost to its present position, minor cycles of a similar kind have occurred repeatedly. Evidence of this is found in small glacial moraines, in the varves, or layers of sediment, deposited in lakes that are now drained, in the vegetation of swamps, and in the strands of salt lakes. Many swamps in Ireland, Denmark, Germany, the United States, and elsewhere show alternating layers of swamp and forest. In some cases pollen grains indicate long cycles, or pulsations of climate. The pollen of conifers, for example, presents evidence of hundreds of years of cool climate. The pollen of the beach tree indicates a similar period of relatively warm, dry climate. In Ireland, for example, remnants of human habitations are associated with trees and pollen indicating a comparatively dry climate, while swamp deposits both below and above indicate that the dry period was preceded and followed by long moist or cool periods.

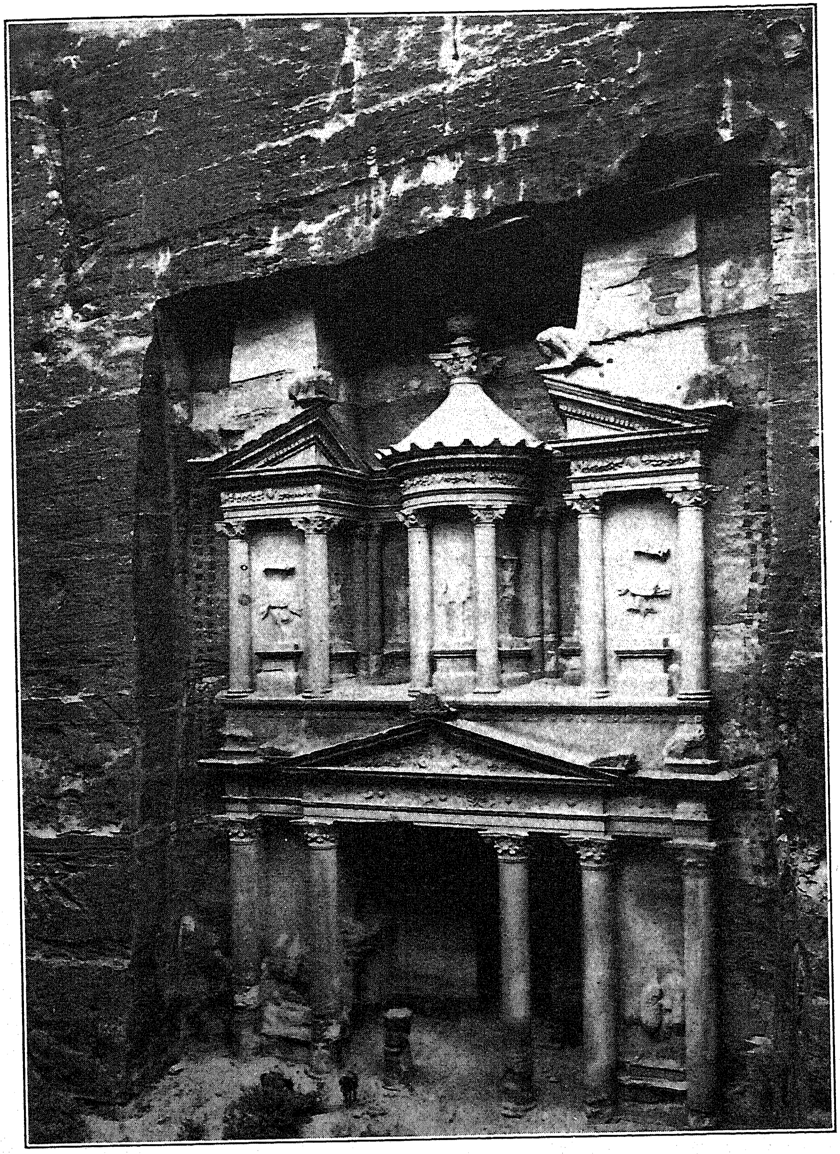
In drier parts of the earth, especially in Mediterranean and desert climates and above all in the zone where the two merge into one another, still other types of evidence indicate climatic pulsations during the historic period. These include abundant ruins, old aqueducts, and abandoned fields in places now too dry not only for agriculture, but even to supply water for villages. Ancient trees whose rings of growth can be measured, old accounts of forests and crops, and even a few ancient weather records agree with the ruins in indicating that in the past there have been climatic pulsations like those disclosed by modern weather records. The pulsations have been of increasing length and magnitude as one goes back toward the glacial period. If the minor pulsations of modern times can produce such strong effects as have been described above, it is clear that the greater pulsations of the past must have been still more effective. As a matter of fact, thousands of waterless ruins in eastern Palestine and Syria, for example, indicate that hundreds of thousands, if not millions, of people once lived in regions now so dry that only a few thousand can get a living.

Ruins and the Moist Phase of Climatic Cycles. It is much easier to detect evidences of the moist phase of climatic cycles than of the dry phase. The so-called caravan cities of Palmyra in the northern part of the Syrian Desert and Petra among the mountains of Edom southeast of

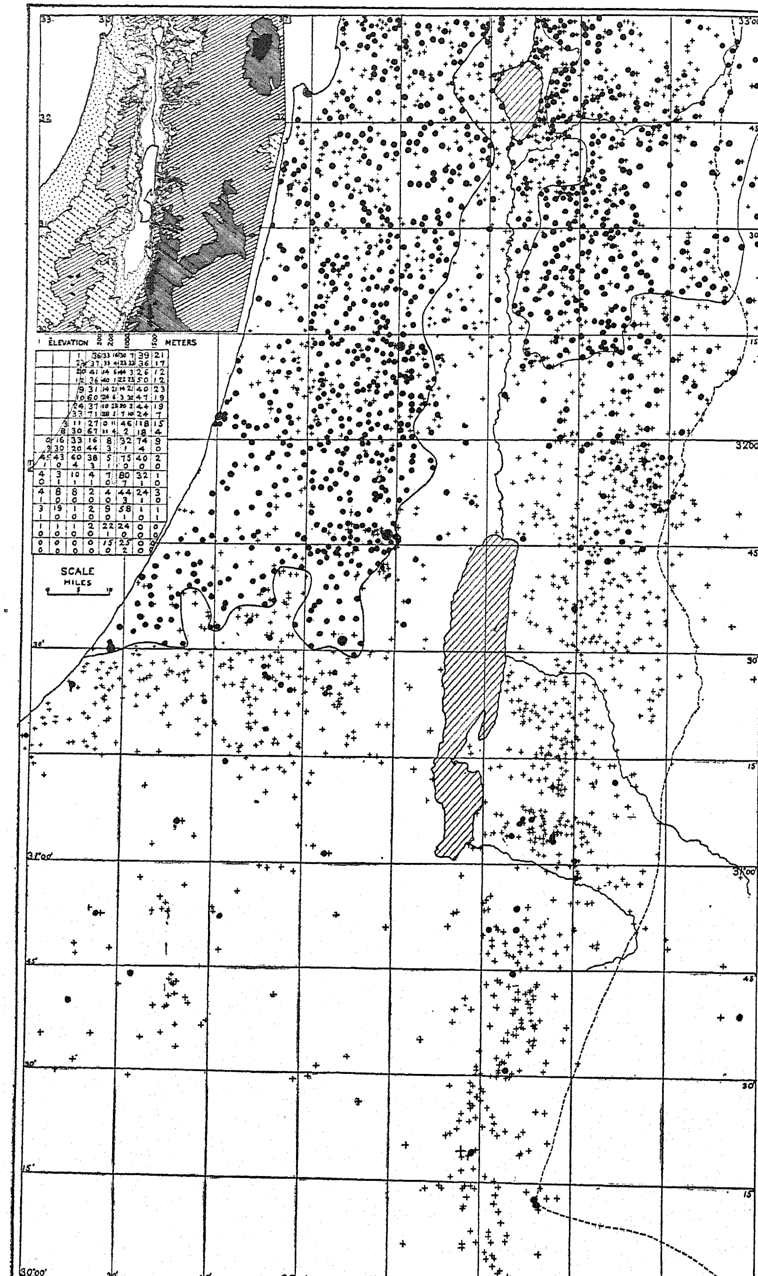
the Dead Sea illustrate this. In the early centuries of the Christian Era Palmyra was a great city as large as modern Damascus, which has a population of 150,000. Ancient writers speak with enthusiasm of its sweet water and beautiful gardens. Its caravans traveled all over western Asia, and it grew so wealthy that its rich citizens took pride in adorning it with wonderful colonnades and temples. Today Palmyra is a vast desolate ruin in the midst of the desert, and harbors only a village of about 1,500 people. Its water is still derived from the old aqueducts, but instead of being sweet and abundant, it has a disagreeable odor of sulphur, and is so scanty that it will irrigate only a few hundred acres of palm trees and gardens.

Petra is even drier than Palmyra—so dry that during most summers there is no water at all. Nevertheless, at the time of Christ and for a century or two thereafter a magnificent city existed here. It was so rich and populous that its people built beautiful temples and carved a huge theater, a grand temple, and scores of beautifully ornamented tombs out of the solid rock. All around Petra, but especially to the north and south where the eastern highlands of Palestine catch the west winds from the Mediterranean Sea, there are hundreds of waterless ruins. A502 shows how numerous they are on the east side of the Dead Sea. Crosses indicate ruins; solid black dots indicate places which are now inhabited. Northeast of Jerusalem a rectangle about 17 by 14 miles in size ($\frac{1}{4}^\circ$ each way) contains 67 inhabited villages and only 27 ruined sites not now occupied, as is evident from the little table below the relief map. Only 30 miles to the southeast, on the other side of the Dead Sea, a similar rectangle contains no inhabited places, although there are 75 ruins. In the entire area south and east of the winding solid line ruins are about 20 times as numerous as modern villages. Only a very few of these ruined sites, if any, could now support villages or towns such as once existed there. The trouble is lack of rain. Practically all the ruins were occupied by people who got a living by raising wheat and other crops, but now such a mode of livelihood is out of the question. In occasional years, to be sure, when cyclonic storms and westerly winds are especially numerous, these places get enough rain so that they might be occupied, but this is extremely rare.

During certain centuries in the past such winds and storms were apparently the rule instead of the exception. We infer this not only from the ruins themselves, but also from an actual weather record kept by Claudius Ptolemaeus in Alexandria in northern Egypt during the first century of our era. Of course this ancient scientist had no thermometer or rain gauge, but he recorded the days of rain, thunderstorms, the direction of the wind, and other facts. When a famous German meteorologist first examined the record he thought there must be some mistake about the



A—Rock-hewn Temple at Petra south of the Dead Sea. This wonderful temple is cut from solid red sandstone in the side of a deep canyon with almost vertical walls. Its size may be judged from the horse in the foreground. In these days the canyon often carries no water at all, or at most a mere brooklet. Formerly, during certain centuries, it carried enough water to support a rich city which probably contained 20,000 or more people.



A—The Past and Present Habitability of Palestine. Dots indicate places that are now inhabited. Crosses indicate ruins. Compare the distribution of ruins with the relief of the land as shown in the upper left hand corner. In each square of the diagram below the relief map the upper figure indicates the number of ruins and the lower figure the number of inhabited places in the corresponding square of the main map.

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place where it was kept. It looked to him like the record of a place hundreds of miles farther north, perhaps Salonika in northern Greece. There is no reason to think that there is a mistake. The record agrees precisely with the ruins and with many other lines of evidence. According to the record, Alexandria used to have thunderstorms and west winds in summer. These do not occur now. The summer is rainless for many months, and an extension of the tradewinds causes the wind to blow steadily from the north. If cyclonic storms followed more southerly courses than now, as they appear to have done at that stage of a long climatic pulsation, Palmyra, Petra, and hundreds of uninhabited ruins could be as populous as they were in the past.

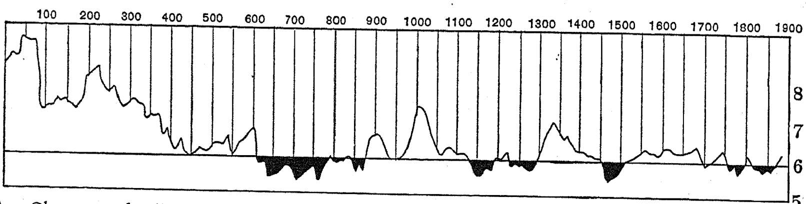
How Salt Lakes Show Changes of Rainfall. Salt lakes are a particularly sensitive index of changes of climate. Having no outlets, they rise and fall in response to increased or decreased rainfall. For example, Owens Lake at the eastern base of the Sierras in California must formerly have been fresh, for an old outlet channel, remnants of a great beach, and cliffs cut by the waves prove that it once stood 180 feet higher than recently and sent out an abundant overflow. When the Los Angeles aqueduct was being built the amount of salt now in the lake was found to be only as much as would be brought in by the Owens and other tributaries in not much more than 2,000 years. Therefore geologists conclude that at the time of Christ or a few centuries earlier the lake must have been a body of fresh water with an outlet. If that is so, the climatic cycle which enabled Palmyra to prosper so greatly must have had a similar effect in southern California. Other lakes in our own country and especially in Asia show similar indications of changes of climate so that their evidence is as widespread as that of ruins.

How the Caspian Sea Shows Alternate Wet and Dry Epochs. The changes of climate during historic times do not seem to belong to one cycle but to several. Since records of the Caspian Sea are available for 2,000 years, that salt lake furnishes an uncommonly good measure of the climatic cycles of the Christian Era. These records relate to two main kinds of facts: (1) the distance from the lake shore to known landmarks, such as old buildings which the lake is recorded as reaching, but which are now above its level; (2) old walls built to keep out enemies in the same way as the Great Chinese Wall, and old buildings which were built on dry land but are now submerged beneath the lake. These kinds of facts indicate that at the time of Christ, or earlier, the Caspian Sea stood at a level 75 or 100 feet above the level of today. Six or seven hundred years later the climate was so dry that the lake stood even lower than now, as is indicated by the submerged ends of two great walls constructed to keep out barbarians. A few hundred years later, however, in the tenth

century, the wet part of a cycle was reached, for a Persian geographer tells us that the Caspian Sea had then risen some 40 or 50 feet to the level of a certain tower, and a little later the water probably rose still higher. It is interesting to know that at this same time Palmyra partially recovered.

This does not end the fluctuations of the Caspian Sea, however, for in the twelfth or thirteenth century a second dry period again lowered the lake level. A century later the old records tell us that the Caspian again rose to a height of nearly 40 feet above the present level. Thus it appears that the Caspian Sea stood at a surprisingly high level at the time of Christ, at a low level six or seven hundred years later, high again about A.D. 1000, low in the thirteenth century, high in the fourteenth, and now low once more. Hence it is clear that there have been two complete main cycles of rainfall since the time of Christ, and we are now in a third.

How Trees Show Climatic Cycles. Within 50 miles of Owens Lake, but on the other side of the Sierras, the famous Big Trees of California furnish a still fuller record of these same climatic cycles and of many



A—Changes of Climate in California During the Christian Era. Black shading indicates drought.

smaller ones during a period of more than 3,000 years. The rings of trees vary in thickness for several causes, but in a dry climate like that of southern California the chief cause is the amount of rain and the season at which it falls. As hundreds of the Big Trees have been cut down for fenceposts and matchwood, it is possible to measure the thickness of the rings as they appear on the stumps. By counting in from the edge it is easy to find a ring that was formed in 1776, for instance, in 1492, or at the birth of Christ.

The rings dating from the time of Christ are thick and indicate that at that time, when Palmyra and Petra had abundant water, when Owens Lake overflowed and there was high water in the Caspian Sea, the Big Trees also had plenty of water and grew rapidly. Six or seven hundred years later when Palmyra was abandoned and when the Caspian Sea stood 15 or more feet lower than at present, the trees formed only narrow rings, because the climate was dry. The way in which the growth of the trees has varied is shown in A504. The high parts of the curve indicate abundant rainfall. The black shading at the bottom indicates periods of com-

parative aridity in the Mediterranean type of climate. In modern times there is close agreement between the longer fluctuations of rainfall in California and Palestine.

Effect of Climatic Cycles upon Man

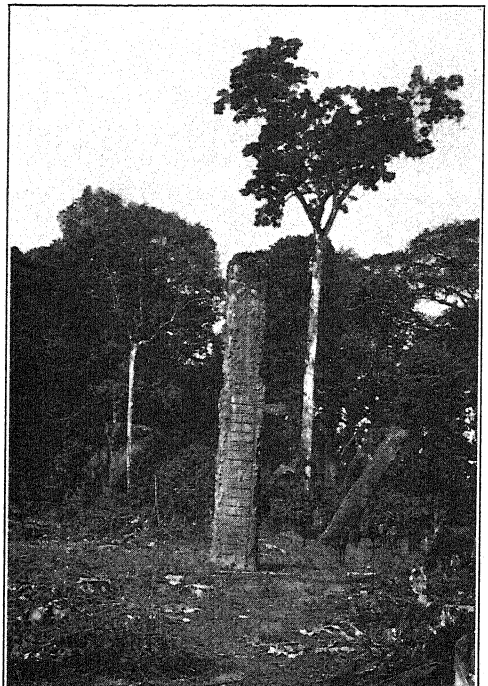
(1) *How Economic Prosperity Varies.* Climatic changes appear to have produced three kinds of effects, economic, political, and physical. In the early days of Rome, about 400 B.C., five acres of cultivated land together with space for pasturage were considered enough to support a family. About 200 B.C., however, when the trees of California were growing particularly slowly and the lakes of Asia were dwindling, a great change became evident. The careful agriculture of the past with its abundant crops and careful fertilization disappeared. The farmers became so poor that many of them gave up their land, which was sold at low prices and fell into the hands of large owners. The new owners stocked it with cattle and sheep since ordinary farming did not pay. The people who remained on the farms fell so deeply into debt that they were almost slaves. Many were so eager to escape from this condition that they flocked to the cities in search of work, until laws were passed which forbade them to leave their homes. This, it will be seen, is like what has happened in our own day during dry periods in western Kansas, only far worse. It happened not only in Italy, but also in other countries around the Mediterranean Sea as far east as Persia and central Asia. Other causes such as exhaustion and erosion of the soil and misgovernment helped to produce these bad conditions. They would not have occurred to any such extent, however, or else would not have done so much harm, if there had been no lack of rain and no dry phase of a long climatic pulsation.

At the time of Christ the return of favorable climatic conditions did much to help Rome recover her prosperity, but two centuries later there began a decline in rainfall which was one of the main causes of Rome's final collapse.

(2) *How Political Life Varies.* The drought and poverty of the dry parts of climatic cycles tend to exaggerate political troubles. For example, in the second century B.C. the taxes which the Roman farmers had previously paid with ease from full grain bins became very hard to pay now that the bins were half empty. This was one cause of what is called the Slaves' Revolt, and other agrarian troubles. The famous Gracchi brothers lost their lives in a vain attempt to remedy the trouble, but when the rainfall increased the remedy was easy.

Another political effect of the dry part of climatic pulsations is barbarian invasions. Nomads such as those of central Asia are the first to

feel the effect of increased aridity. The springs in the desert dry up, grass for pasturage is unusually scanty, and the nomads are forced to seek new pastures. Many of the barbarian invasions of Europe during the early part of the Christian Era appear to have been due in part to increasing aridity. Finally, in the seventh century, the greatest of all outpourings from the desert occurred just at the time when the trees, the lakes, and the ruins indicate that the climate of subtropical and desert regions was driest. Under the influence of the Mohammedan religion the Arabs surged out and overwhelmed all the surrounding regions. Their new religion kept them together and guided them, and the dryness of the desert apparently made them ready for a migration.



A—Ancient Maya Stele, Stone Pillars Covered with Hieroglyphics in a Dense Tropical Forest at Quirigua in Guatemala. One of the amazing things indicated by these ruins is that the ancient Mayas were able to cultivate the land profitably for long periods in regions where this is now almost impossible.

(3) *How Human Energy Varies.* We have already seen that variations in the weather from day to day are one of the greatest stimulants to human activity. Apparently the part of climatic cycles which has abundant rain in subtropical climates has many more storms and much more variable weather than the dry part of the cycle. Therefore the wet part is stimulating and people have much energy. This seems to be one of the reasons why the people of Greece, Palestine, Egypt, Mesopotamia, and Persia were more energetic in the past than at present. In those days they apparently had somewhat the same kind of climatic stimulus as the people of the United States and northwestern Europe now profit by. Athens probably had a climate as healthful and stimulating as that of New York. It was too hot in summer just as New York is too cold in winter, but the net effect of all the seasons appears to have been excellent.

Man's Changing Response to Temperature

Today man seems to flourish most in cyclonic regions where the mean annual temperature is about 50°. This is almost exactly the temperature of New York, Chicago, London, Paris, and Berlin. Most of the earliest civilizations, on the other hand, arose in subtropical climates; and the center of civilization has been gradually, but irregularly, moving toward colder lands during the last 5,000 years. Sometimes, to be sure, the center has returned equatorward, as happened when the Roman Empire was waning. These backward movements into warmer regions have usually coincided with a distinct decline of civilization. It appears, therefore, that, up to a certain point, the higher the civilization, the cooler the climate in which it flourishes most vigorously.

The explanation of this apparent law seems to lie in the following facts: (1) As the human race has risen in civilization it has learned how to conquer the low temperature of northern winters by better clothing and food, by tighter houses, and by the use of fuel, stoves, furnaces, window glass, and other appliances. Thus low temperature has become less and less of a handicap, while prolonged heat, such as is experienced in the old centers of civilization during the summers, is still almost as much of a handicap to civilized man as it was to savages. Hence civilization tends to move northward as men learn how to dwell comfortably in colder lands.

(2) The earlier civilizations were based almost wholly on a primitive type of agriculture with poor tools and only the crudest kind of plows. Even such common tools as iron axes were clumsy, scarce, and hard to sharpen, while metal saws, chisels, and hammers were unknown to practically all the peasants. With such equipment it is especially difficult to clear hardwood forests and get rid of turfy grasses. Regions with the Mediterranean type of climate do not have large forests, and their grasses tend to be small bunchy types which can easily be uprooted by hand, or by plows which are merely pointed sticks of wood. The mild winters in such climates make it easy to raise winter wheat and barley. The dry summers foster such unusually valuable crops as olives and grapes. They also make it easy to raise an abundance of fruits and even vegetables if water is available for irrigation. The hills which cannot be cultivated provide broad natural pastures where cattle, sheep, and goats can be fed at all seasons without any labor for clearing the forest, and without the danger of loss which is great where animals are pastured in unfenced forests. Thus many conditions combine to make the Mediterranean regions a place where agriculture is especially easy and profitable for primitive farmers. The cyclonic type of climate, on the contrary, fosters the growth of hardwood forests and of grasses that soon make a tough turf unless the fields are carefully weeded and well plowed. Long experience and

considerable development of the use of iron tools were necessary before man was skilled enough to make good use of the cooler, more rainy cyclonic climates. It is hard for us to realize how slowly and with what difficulty such skill was acquired.

(3) Equally long experience and skill were needed before mankind could have as good health and hence as much energy in the cooler, moister climates as in the Mediterranean type. Cyclonic storms are undoubtedly a valuable stimulus to health and energy, but the regions where they occur have the disadvantage of being cold and wet in winter. Even with all our skill the doctors are especially busy in winter, and the deathrate is high. In places such as Sicily, where people still have few facilities for protecting themselves from cold damp weather, the deathrate rises in winter far more than with us, even though the weather is not very cold. Before people could preserve their health in cyclonic climates as well as in the Mediterranean type they had to acquire rather high skill in making woolen clothing, building houses that could be kept warm and light at the same time, and devising means so that their animals could be fed and milked in cold, wet weather without making people ill with pneumonia or other respiratory diseases.

In addition to all this, until the arts of agriculture and commerce had reached a high stage, the Mediterranean type of climate excelled all others in providing man with a good diet. The cereals, fruits, and animals which it fosters supply a well-balanced diet in which fruits, milk, and meat supplement wheat, the best of cereals, and provide an unusually good balance of protein, carbohydrates, fats, vitamins, and acids. Not until modern times was it possible for the people of cyclonic regions as a whole to have a diet as good as that of the Mediterranean regions. This became possible only when man learned to raise vegetables on a large scale, plant many fruit trees, and store up food products through the winter and carry them long distances. During the centuries since ancient Greece was in its prime, gradual improvements in man's ability to protect himself against bad weather and to provide himself with a good diet in winter as well as summer have made it possible for him to have better health in cyclonic regions than in those of the Mediterranean type, but the process has been slow.

(4) Finally, the movement of the center of civilization from Mesopotamia and Egypt to Greece and Rome, and then to the North Sea countries and America, has been influenced by the effect of the weather on mental as well as physical activity. We have seen that people's mental activity is greatest when the outside temperature averages somewhere in the neighborhood of 40° or 45°. They cannot get the full stimulus of such conditions, however, unless they can protect their health. We have

also seen that cyclonic storms are a decided stimulus to mental as well as physical activity. Such facts lead to the conclusion that as man has learned more and more about protecting himself from cold and moisture, and about supplying himself with a good diet, he has gradually been able to preserve both health and comfort in climates which are highly stimulating, but which were too severe for a more primitive state of civilization. Thus, even if there had been no cycles of climatic change and no shifting of the main storm belt, the mere progress of civilization would presumably have gradually carried the centers of the world's activity from warmer to cooler regions.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Palestine, when first occupied by the Children of Israel, is described as a land flowing with milk and honey. A little farther north in Syria, according to a careful American archeologist, at about the time of Christ, "an area embracing somewhat more than 20,000 square miles was more thickly populated than any area of similar dimensions in England or in the United States is today, if one excludes the immediate vicinity of the large modern city. . . . Mile after mile of this barren gray country may be traversed without encountering a single human being. Day after day may be spent in traveling from one ruined town to another without seeing any green thing save a terebinth tree or two standing among ruins. . . . No soil is visible anywhere except in a few pockets in the rock from which it could not be washed by the torrential rains of the wet season. Yet every ruin is surrounded with the remains of presses for the making of oil and wine. Only one oasis has been discovered in these high plateaus."

Explain the preceding facts. Show how and why man's surroundings in Palestine and Syria have changed in each of the following respects: (*a*) vegetation; (*b*) soil; (*c*) agriculture; (*d*) density of population.

2. Study the diagrams of rainfall in subtropical, monsoon, and mid-continental regions, A112, A113, and A420. Show in each case what effect a diminution of rainfall and a shortening of the rainy season would have upon the following conditions: (*a*) the seasons of planting and reaping; (*b*) the character of the crops; (*c*) the use of animals; (*d*) the depth of soil on the mountains. Which of the three kinds of regions would be most influenced? Why?

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PART X

MAN'S RELATION TO MAN

CHAPTER XXVI

POLITICAL GEOGRAPHY

In all parts of the world geographical surroundings have a strong influence on political conditions. This is equally true among primitive people and among those most highly advanced. For example, in eastern Persia the chief political idea of the primitive "Fowlers" who live on birds and cattle in the vast swamps of Seistan is to evade paying taxes. They do this easily because they live in a geographical environment which favors nomadism. Being nomads, they can readily hide themselves and their simple belongings among the tall reeds where the tax collector cannot find them. The settled agricultural people on the open irrigated lands not far away, on the contrary, look upon taxes as no less inevitable than the seasons, for their environment furnishes no way of escape. Among advanced people environment produces a similar political effect when it causes the coastal sections of a country to vote for ship subsidies, while the interior is strongly against them. Each of the great elements of geographical environment plays its part in causing political differences. The size of a country, its location in respect to other countries, and the land forms, water bodies, soil, minerals, climate, plants, and animals within its limits or on its borders all influence the relations of one country to another. They also cause some of the country's own people to want the government to act in one way and some in another, thus creating political differences.

Size as a Political Factor

Large countries and small countries each have advantages, but they are different. Large countries, for example, are more likely than small ones to maintain their independence. They are also more likely to be self-sufficient, and to be able to supply their own needs in time of war as well as peace. The United States has a greater variety and abundance

of minerals than any other country, as we saw in Chapter XIV, and the Soviet Republic comes next. Large countries have the further advantage of enjoying free trade with more people than do small countries. One of Europe's greatest difficulties is its thousands of custom houses. Another advantage is that, other things being equal, large countries which have a large population are well represented by their own governments in foreign countries, so that their rights and privileges are well cared for.

On the other hand, large countries are much more likely than small ones to suffer from internal friction. They often include within their borders people who differ radically in race, language, religion, and habits. Such differences caused the old Austrian Empire to go to pieces after the first World War. Even if the people are everywhere similar in a large country, they are likely to have diverse interests because they live in different kinds of environments. Collectors of wild rubber in the Amazon basin have very different interests from those of coffee planters in the south of Brazil. An industrial half of a nation may have interests strongly opposed to those of an agricultural half, as was notably the case in England two or three generations ago. A backward section may prevent a progressive section from trying new methods, as happened in China when the south wanted a republic but the north supported the old monarchy. A poverty-stricken section may be a constant expense to the taxpayers of a more prosperous section, as has happened more than once in the United States. Comparative unity of occupations, ideals, and mode of life makes such occurrences rare in small countries, and thus is a great advantage.

Size and Independence

The degree to which countries of different sizes are able to retain their independence is illustrated by the table of areas in the *Statistical Yearbook* of the League of Nations. Before Germany took Austria in 1938 that book listed 207 governmental units, 66 of which were self-governing either as independent countries, or as parts of the British Empire. The remaining 141 were colonies or dependencies. The percentages in the following table show that the large units were far more likely than the small ones to be independent.

Area in Square Kilometers (1000 km. = approximately 400 sq. mi.)	*Number of Units*	*Percentage Self-governing*
Under 10,000	67	12
10,000 to 100,000	52	27
100,000 to 400,000	40	43
Above 400,000	48	56

The precarious condition of small countries in times of political upheaval is illustrated by the fact that from 1938 to 1940 political independence was lost or greatly impaired in no less than 8 of the small countries in the second group of this table, namely Albania, Austria, Belgium, Denmark, Estonia, Latvia, Lithuania, and the Netherlands. In the third group 5 countries, Czechoslovakia, Finland, France, Norway, and Poland, suffered in the same way, but Finland and Norway have a very small population. Among the really large countries a serious loss of independence occurred only in China. In time of war a big country has a better chance than a small one to defend itself. Not only does its greater variety of products help it to be self-supporting, but its long boundaries afford opportunities for importing supplies from abroad. In case of invasion the mere size of a country may make it impracticable for the invading enemy to govern the country completely, as the Japanese have found in China. In spite of this, however, such huge units as India, the Sudan, Belgian Congo, and even China are not really independent. Size alone is no guarantee of independence.

Largest Countries	Area in Thousands of Square Miles	Population in Thousands	Smallest Countries	Area in Thousands of Square Miles	Population in Thousands
1. Soviet Republic	8,096	170,000	Greece	50	6,937
2. Canada*	3,467	10,377	Nicaragua	49	1,134
3. Brazil	3,283	45,133	Hungary*	45	9,748
4. U. S. A.*	3,027	127,000	Liberia	45	1,500
5. Australia*	2,975	6,775	Cuba	41	4,011
6. China*	2,903	423,000	Guatemala	45	2,466
7. Mongolia	1,368	1,800	Iceland*	40	117
8. India	1,807	353,000	Bulgaria*	40	6,078
9. Argentina	1,078	12,561	Portugal	35	6,826
10. Mexico*	767	16,523	Panama	34	467
11. Iran	628	15,000	Irish Free State*	27	2,966
12. Bolivia	507	3,226	Costa Rica	23	592
13. Manchukuo*	503	34,000	Dominican Republic	19	1,545
14. Peru	482	6,500	Bhutan	18	300
15. Union of South Africa	472	9,498	Denmark*	17	3,706
16. Tibet	463	2,000	Switzerland*	16	4,066
17. Colombia	441	8,699	Salvador	13	1,450
18. Venezuela	353	3,452	Netherlands*	13	8,557
19. Ethiopia	350	7,600	Belgium*	12	8,331
20. Turkey*	294	16,158	Haiti	10	3,000

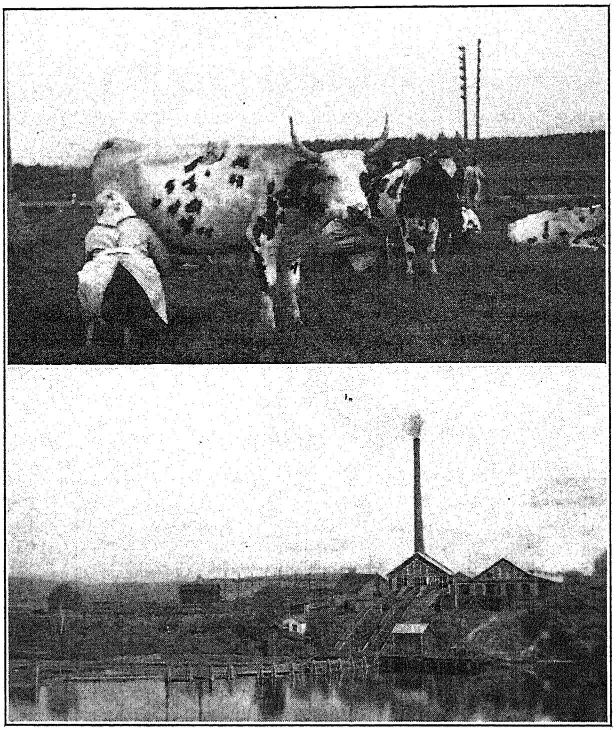
* Asterisks indicate the country in each pair which is generally considered the more advanced.

Size and Progress

The size of a country seems to have little relation to its progress and prosperity. Opinions about this vary so much that we may well make a careful study of the table preceding this paragraph.* The table shows the size and population of the 20 largest countries and the 20 smallest that are sufficiently independent to be reckoned as distinct countries. In no pair of countries is the area of the larger less than about 30 times

A

B



A-B—Typical Activities of Northwestern Europe. A. Milking cows at noon in a pasture of Finland. B. Sawmill at the mouth of a river in southeastern Norway.

that of the smaller one opposite it. In some pairs, such as 5 (Australia and Cuba), and 19 (Ethiopia and Belgium), the population of the two is not very different; in others (pair 16, Tibet and Switzerland, and pair 18, Venezuela and the Netherlands), the smaller country, although only about one thirtieth as large as the other, has twice as many people. On the other hand, India (number 8) has nearly sixty times as many people

* This table should form the basis of a careful map study.

as little Bulgaria, and China (number 5) exceeds Guatemala almost 200-fold.

On the basis of a rough estimate of the relative progress of each pair of countries (a large one on the left and a small one on the right), the more progressive country is starred. Pair 1, however, receives no star because it is difficult to say whether the Soviet Republic, with its ambitious attempts to industrialize itself, or Greece, with its remarkable record of absorbing a million and a half new people after the first World War, is more progressive and prosperous. In the next, it is clear that Canada is far ahead of little Nicaragua, whereas in the third comparison the small country (Hungary) is almost equally ahead of the large one (Brazil). Between the United States and Liberia (pair 4), or between Australia and Cuba (pair 5) there can be little doubt as to which is ahead. In the next pair (number 6) China, in spite of its recent troubles, is undoubtedly ahead of Guatemala.

Iceland and Mongolia (pair 7) are so little known to the world at large that many people do not recognize them as separate countries, and do not know quite where they are. This is due largely to the backwardness of Mongolia and the small population of Iceland. The cool, volcanic, stormy island of Iceland, however, in spite of having a population less than that of Wichita, Kans., has made progress about as fast as any country in the world. It is not rich, but the general standard of comfort is astonishingly high in proportion to the scanty resources, which comprise little except sheep and fish. In this respect it is like several other countries in high latitudes, namely, Norway, Sweden, Finland, and the Falkland Islands. Mongolia, on the other hand, is still largely a country of desert nomads.

The most progressive parts of India (number 8) would be considered by some people as progressive as Bulgaria, but others would dispute this. Bulgaria, although it is a "peasant state," shows a degree of general comfort and progress which is nowhere matched by an equally large population in India. Moreover, India has vast sections where poverty and ignorance prevail to an extent unknown in Bulgaria.

Although Argentina (number 9) is a new country and little Portugal, with which it is paired, is an old country, their general culture stands at so nearly the same level that neither of them is starred in our table. However, Argentina is certainly the more wealthy of the two, and Buenos Aires is more magnificent than Lisbon. The cultural difference between Mexico and Panama (pair 10) is probably greater than between Argentina and Portugal. In such places as the rainforest of southern Yucatán, to be sure, Mexico has a population of wild Indians about as primitive as those who live in the still more luxuriant forest of eastern Panama.

The Republic of Panama, on the other hand, has no great metropolis such as Mexico City on its high plateau, and no such industrial cities as Puebla near Mexico City and Monterey in the north. Its fame is derived largely from the work done there by other countries.

Iran or Persia (number 11) possesses famous and beautiful cities such as Isfahan and Teheran. Much of the country, however, is a desert studded with oases where the people live in mud houses and are on the verge of want much of the time. Not even the most progressive and prosperous parts in the northwest claim standards of living so high as those in most of Ireland. In the next comparison (pair 12) it is hard to choose between Bolivia and Costa Rica. Each has its main center on a tropical plateau, but includes a considerable amount of lowland rainforest. The Bolivian plateau is much the more elevated of the two. For this reason, and also because it has no seacoast and lies south of the equator, Bolivia is the more isolated. Nevertheless, it has considerable mineral wealth which brings it into contact with foreigners. Much of its population consists of Indians who still live in about the same way as they did before the days of Columbus. Costa Rica, on the other hand, is more nearly a white man's country than is any Latin American country except the three in the far south. A coastal fringe of Negroes does not alter the fact that for a tropical country it ranks quite high in culture and in the general comfort of its people. Banana plantations along the coast help in this respect.

Manchukuo (number 13) is so new a country that we cannot yet tell just how it will rank when it has settled down into maturity. Its 30 million or more Chinese are the result of an enormous immigration within the present century. They appear to be at least as enterprising as the average people in the north of China. Its few hundred thousand Japanese are largely merchants, officials, and soldiers, and are decidedly competent. Thus there can be no question that Manchukuo stands far ahead of the typically tropical people of the Dominican Republic. Peru and Bhutan (pair 14) are mountainous countries in low latitudes. Bhutan, however, is so hidden away in the lower Himalayas and has so small a population (scarcely more than one thirtieth that of Belgium, which is only two thirds as large) that few people know anything about it. It has no great city such as Lima, and no copper mines or sugar plantations such as those which attract foreigners to Peru. Nevertheless, the few travelers who have been there give the impression that if the Bhutanese were as numerous as the Peruvians they might not fall behind them in either progress or political influence.

A comparison between the Union of South Africa and Denmark (pair 15) emphasizes one of the chief contrasts between large countries and

small ones. South Africa is highly diverse. Cape Town and Cape Colony need not fear comparison with any country culturally, but vast parts of the Union are only just emerging from barbarism. Denmark, on the contrary, ranks uniformly high in all of its small area.

In pairs 16, 18, and 19, three of the world's most advanced countries (Switzerland, the Netherlands, and Belgium) appear among the small countries, and are compared with three distinctly backward large countries (Tibet, Venzuela, and Ethiopia). The two sets of countries go to opposite extremes in several respects. The three small ones lie in high latitudes, whereas the others lie in low latitudes (although Tibet extends quite far north). The small countries border the sea and lie near some of the world's most powerful and progressive large countries. Tibet and Ethiopia have no seacoast, and Venezuela lies far from any highly progressive country except the United States. We think of the three large countries as highly mountainous, but they are no more so than their little companion, Switzerland. Moreover, Venezuela possesses vast plains, the llanos of the Orinoco Valley, and Tibet, in spite of its great height, has plenty of gently sloping land. Therefore, we cannot ascribe the backwardness of the large countries to the relief of the earth's surface. In pair 17, on the other hand, the large country (Colombia) differs little from the small one (Salvador), except that its plateau and mountains are higher. Finally, Turkey with its strenuous attempts to modernize itself has gone far ahead of Haiti with its large remnants of African barbarism.

In this whole comparison we have found large countries ahead in 7 of the pairs in our table, and small countries in the same number. In 6 pairs we have not been able to say which is more advanced. If we reverse the comparison, essentially the same result is obtained. By reversal we mean comparing number 1 among the large countries (the Soviet Republic) with number 20 (Haiti) among the small ones, number 2 large (Canada) with number 19 small (Belgium), and so on. Other geographers might rank the countries a little differently from the way it is done here, but it is clear that both large and small countries stand at all levels of prosperity, industry, progress, and political influences. Although size may have a great deal to do with a country's ability to remain independent, it has little to do with progress and prosperity.

Examination of a map shows that neither small nor large countries are more common in one type of climate than another. It also shows very plainly that isolation helps a small country to remain independent. Five of the 20 small countries in our list are isolated by being located on islands. Eight of the others are helped in the same way by mountains. Two, Liberia and Panama, are independent only because they have been under American protection ever since they first became political units.

In fact it is doubtful whether Cuba, Guatemala, Costa Rica, Salvador, and Haiti would be independent if it had not been for the Monroe Doctrine. The other small countries owe their independence largely to their own efforts, plus the protection afforded by islands and mountains.

The ones which owe most to their own efforts are Denmark, the Netherlands, Belgium, and Hungary, but the first three of these were overrun by Germany in 1940. These four are the only small countries in our list which are located in accessible lowlands where they can be easily conquered by other nations unless they possess extraordinary ability to maintain their independence. Together with Switzerland, Ireland, and Iceland, they are the ones where general progress and comfort rank highest. It appears then that, although size has little to do with the progress and prosperity of a country, small countries are not likely to retain their independence unless they have one of three advantages: (1) protection by some large country such as the United States; (2) mountains or ocean barriers that keep them apart from other countries; or (3) unusually competent people. Even before the last World War Belgium, the Netherlands, and Denmark, which are the least protected of the small countries, were able to maintain their independence only because larger countries, such as France and Great Britain, protected them. Belgium almost lost its independence in 1914. Then in 1940 not only Belgium, the Netherlands, and Denmark, but 7 other countries with a small area or a small population lost their independence. Switzerland, Hungary, and Bulgaria feared that either Germany or Russia would invade their territory, or in some other way control their actions. Rumania, a somewhat larger country, but not of great size, was reduced to small proportions.

Advantages of Small Countries

The disadvantages which small countries have in maintaining their independence and in making themselves self-sufficient are to a considerable degree balanced by the advantages of greater internal unity. Few of the small countries in the preceding table have any serious problem because of differences in race, culture, language, religion, or types of occupations within their own limits. Belgium, to be sure, has some friction between its Dutch-speaking Flemings and the French-speaking remainder of the population, the Walloons, but this does not create much difficulty. Switzerland has sections where German, French, and Italian are the respective languages, but the habits, occupations, and ideals of all three groups are so much alike that this makes practically no trouble. Costa Rica has a white section on the highlands and a less populous colored (Negro) fringe around the coasts, and the whites are trying to prevent

the others from spreading. Panama possesses a tract of equatorial rainforest where savages still roam. Nevertheless, in spite of such internal divergencies, the small countries are on the whole characterized by a high degree of unity among their people. Such unity is one of the reasons why some small countries, especially the Netherlands, Belgium, Switzerland, and the Scandinavian countries, have a surprising degree of influence in proportion to their population. This is especially remarkable in the case of Switzerland which has no colonies and no seacoast to help it. Iceland, too, with only about 100,000 people and extremely limited natural resources, influences the world far more than do the vast provinces of Brazil, China, India, or Mexico where there are millions of people.

Internal Friction in Large Countries

Large political units almost invariably have trouble because of their great diversity. The Soviet Republic claims that 176 languages are spoken within its borders. Its people vary from the progressive, industrial type found in the Leningrad district to untamed nomads in Turkmenistan and northeastern Siberia. The Republic includes people with the habits and occupations of warm deserts, cold tundras, vast cool plains, and rugged mountains. It includes 11 federated republics and 22 autonomous republics which are generally smaller than the others. Finns, Uzbeks, Turkmens, Tatars, Jews, Georgians, Greeks, and Armenians all form non-Slavic groups, each with at least a million and a half people. Khirghiz, Germans, Kalmuks, and many other nationalities are represented among the republics. Even the great Slavic group of the Ukraine Republic, with 32 million people, shows signs of wishing independence. Like many of the other racial groups it might break away from the main republic if the central government should be weakened. The great Soviet Union could scarcely hang together if it were not that it has a central core of well toward 100 million Slavic people who live in the vast central plain and are very uniform in habits and ideas.

One of the great worries of the Russian government is the vast distance which separates the Pacific Coast of the country from the main European section. The two parts are separated by an almost uninhabited cold plateau east of Lake Baikal. They are connected only by the narrow thread of two railway lines, on both of which traffic can be easily interrupted, specially in winter. Fear of war with Japan leads the government to spend vast sums in maintaining an army and a great amount of military equipment in the remote eastern section where the population is insignificant. Many people believe that Russia would be far stronger if it gave up several million square miles of its less homogeneous territory, especially in the far east.

Canada likewise suffers from its great size and from containing two diverse types of people. Its population is scattered along the southern border in isolated groups like beads, each bead having a different color and being composed of a different material from the others. The eastern bead comprises the Maritime Provinces, mainly English-speaking, but with a few French. It is interested in fishing, farming, and trade with European countries. The next bead is separated from it by 200 miles of high forested land so cool that there is little agriculture and few people. Then comes the first of two very diverse beads which lie close together. This bead is French Canada, centering in the St. Lawrence Valley from Quebec to Montreal. It, too, is interested in farming, and Montreal is a great commercial center. Nevertheless, French Canada wants mainly to be left alone. Farther southwest in the region of Lake Ontario and Toronto the third bead touches the second, but is intensely English both in speech and sympathies. The history of Canada is full of the conflict between French Quebec and English Ontario.

Close to 1,000 miles of rough, heavily glaciated, and sparsely populated country must be traversed before the fourth bead is reached in the great grain-raising plain from Winnipeg to Edmonton. This wheat-raising section, being almost identical with neighboring parts of the United States in people and occupations, has much more to do with St. Paul, for example, than with distant Toronto. West of it 500 miles of rugged mountains, the Rockies and others, must be crossed before the last small bead is reached in British Columbia near Puget Sound. This bead is interested in trade with Asia. It fears war with Japan and is determined not to permit Asiatics to settle within its borders. It cares little for the problems of Europe, or for the conflicting interests of Ontario and Quebec, or for the plans of the Great Plains for socializing the government and bringing prosperity to agriculture, especially wheat raising. The problem of getting the five beads to work together and of financing railroads to cross the great waste spaces between them has troubled the Canadians greatly.

In China the problems created by vast size have been far worse than in either the Soviet Republic or Canada. Chosen and much of Indo-China in earlier times, and Manchukuo, Mongolia, Sinkiang, and Tibet in our own times are outer sections of China which have split off from the main body because the Chinese Empire was too big, too diverse, and too unwieldy to persist as a single political unit. Time and again, too, the conservative north has been pitted against the progressive south. The capital has repeatedly shifted between Peking (northern capital), now called Peiping, and Nanking (southern capital). Again and again for long periods many Chinese provinces, especially the outer ones, have been ruled almost independently by their own governors. Japan has been able to overrun

large parts of China largely because the people in different sections are so remote from one another that they are not much interested in what happens elsewhere, and cannot help much, even if they are interested. China's mere size has been a terrible source of weakness. Only when China has had a very strong central government has its size given it power.

Peru and Bolivia are so large that each of them is sharply divided into a relatively progressive plateau section and an extremely backward lowland section of tropical rainforest, or of jungle and scrub. Peru, Ecuador, and Colombia have quarreled bitterly over the part of this relatively useless territory where they approach one another on the upper Amazon. Bolivia and Paraguay fought a long war over the part where the Pilcomaya and Paraguay Rivers afford a waterway from the Atlantic Ocean to oilfields as well as to scrub forests.

Peru, because of its great diversity, has another conflict. The comparatively cool but very dry and narrow plain along the Pacific Coast, with Lima as its center, wants to encourage foreign trade, irrigation, and the sugar industry. The cooler and much more inaccessible Andean plateau is interested chiefly in stock raising and mining.

Brazil possesses so vast an area of rainforest, jungle, and scrub that it can do little to develop two thirds of its whole territory. So poorly is the country developed that one can travel in a straight line from the Atlantic Coast westward across the whole continent without crossing a single railroad or paved motor road. Starting south of the Brazilian city of Bahia one would travel about 2,300 miles in Brazil and another 600 or 700 in Peru to Payta south of Cape Blanco where South America juts farthest west. All the way one would see little except tropical scrub, savanna, and rainforest, with some tropical jungle, many rivers, some high mountains, and finally a bit of desert close to the Pacific Coast. Along a north and south line, one can travel almost equally far and see almost equally little sign of modern man. If one starts near Caracas in Venezuela, and travels toward Asunción in Paraguay, one will be in Brazil most of the time. The political problem of how to use these vast waste spaces to the advantage of the utterly different type of civilization found along the coast and on the eastern plateau from Cape San Roque southward is extremely difficult. It is complicated by the problem of how to reconcile the predominantly Portuguese section of the country, extending from Rio de Janeiro northward, with the predominantly Italian, Spanish, and German section, extending from São Paulo south. Time and again the Paulistas, as the southerners are called, have been ready to revolt because they claim that the Rio de Janeiro group does not treat them fairly.

In the United States, Australia, and Argentina mere size and consequent diversity probably make as little trouble as in any large countries.

This is mainly because these countries are new and have been settled by comparatively homogeneous people, or at least by people who want to become like the older settlers in speech and customs as rapidly as possible. Nevertheless, Argentina has a grave conflict between its great city of Buenos Aires in the center, the grain-raising country round about for a few hundred miles, the cattle country outside of that, and finally the sugar lands in the north, the fruit country in the west, and the sheep country far south in Patagonia.

Australia, like many another large country, would probably be better off if a large part of its territory were sunk under the sea. This is true not only of the vast desert, but perhaps even more of the northern region of scrub forests and savannas with its wet and dry low-latitude climate. A submergence of these areas would give the remainder of Australia a more humid climate and greater capacity for supporting population than it has now, and would get rid of a constantly irritating problem. The Northern Territory of Australia contains only 5,000 white people and 18,000 natives in 524,000 square miles, and the population does not grow appreciably. The federal government has poured out money on the poor northern parts of the country, making surveys and explorations, helping settlers, subsidizing cattle ranches, and building useless railways. A conspicuous example of waste has been the building of a railroad northward 1,000 miles from Adelaide to Alice Springs (Stuart) in the midst of a vast desert. There is practically nothing for the road to carry. Trains run about once a week, and even then are very short. Nevertheless, the Federal Government is bound by a promise to complete a railroad to Port Darwin on the north coast. South Australia gave up its rights in the northern part of the country only on condition that such a railway be built. It would be sheer waste of money to finish the road. Nevertheless, many Australians want it because they fear that, if the white man does not utilize the waste spaces of northern Australia, the Japanese or other Asiatics will surge in and occupy the land. One of Australia's most hotly contested political problems has been what to do about the whole problem of a "White Australia" and the unsettled tropical north, where nobody wants to live.

Political Effects of Size and Diversity in the United States

Among the large countries of the world the United States probably suffers as little as any because of size and diversity. One reason for this is that all parts of the country have climates in which white men can live comfortably, and only a small part, relatively speaking, is too extreme for agriculture. Added to this is the fact that because the country is new and prosperous its active people move around so much that large numbers

of almost the same kind of people are found in all parts. Europeans often say that the sameness of the various sections destroys the joy of travel. At Tucson in Arizona, Spokane in Washington, Concord in New Hampshire, and Jacksonville in Florida, people wear clothes made in New York, eat food out of the same kinds of cans and packages, live in houses of the same shape, size, and color, read the same syndicated columns in the papers, see the same movies, and talk the same slang. The Europeans may not like all this, but it is a good thing for us. It helps us to have somewhat the same sort of unity that little Denmark has, although not to so high a degree. The more we can overcome the differences due to our diverse geographical environment, or at least can prevent them from making one section quarrel with another, the better.

Political Diversity within the United States

It is impossible for the United States, or any other large country, to prevent geographical differences from giving rise to political problems. For example, until the United States adopted the quota system the East and the West had quite different ideas about immigration. The western United States, which faces Asia, did not want Asiatic immigrants. Its people felt so keenly on this question that they engaged in riots against the Chinese and Japanese, and compelled the country to adopt the policy of excluding these races. The East, because it faces Europe, is indifferent about Asiatics, but has always been intensely interested in European immigration. For many years the East wanted as many immigrants as possible, and hence was against all restrictions. Now, however, the East believes itself to be in much more danger from undesirable immigrants than the West. Now that immigration on our coasts is closely regulated, the storm center in this respect is the Mexican border.

The coasts and the interior of the United States often put different kinds of pressure on Congress. Both coasts agree as to the wisdom of large appropriations for harbor developments, and in both sections there is a strong sentiment for a large navy and "adequate" coast defenses. Both coasts also want laws to encourage export trade. The East, however, having a large surplus of manufactured goods, wants to discourage the importation of similar goods from Europe. The West, on the other hand, having no great manufactured surplus and being face to face with great Oriental sources of raw material, wants to encourage imports of almost any kind. The interior states, however, are inclined to say that the United States is so strong and rich that no country will ever dare attack it. They believe that the country will prosper no matter whether the government helps foreign trade or not. What they want is large appropriations for river improvement, national highways, irrigation

projects, forest reserves, national parks, soil preservation, and agricultural bonuses. They say that if vast sums are spent to deepen harbors on the Atlantic or Pacific coasts, equally large sums ought to be spent for improvements in states which have no sea-borne commerce.

This conflict of interests often leads to log-rolling and results in the so-called pork-barrel bill. Congressmen often try to get appropriations for their own district regardless of the rest of the country. It is a grave mistake to think that money should be spent in one's own particular district whether it produces national benefit or not. Money spent on New York Harbor, for example, benefits almost every part of the country, because it stimulates trade and increases the profit on both imports and exports. The coast states err when they oppose the spending of money for irrigation, or for the building of great national highways. These examples illustrate how prejudice and greed may be fostered by the geographical location of a place. A project such as the St. Lawrence waterway should be judged from the standpoint of the country as a whole (page 263).

Climate and the Civil War. The greatest effect of geographical diversity upon political conditions in the United States is connected with climate and crops. Because of their climate the southern states are among the best places for cotton and tobacco, which are usually two of the world's most profitable crops. Strange as it may seem, this fact has in one way been a decided disadvantage, for it led to the entrenchment of Negro slavery. The early settlers soon found that they could make great profit out of tobacco if only they had laborers, and when cotton became still more profitable the need of laborers increased. Since white people of the northern races are averse to working much out of doors in the South, especially in summer, owners of large farms or plantations began bringing black slaves from Africa.

No one then thought this wrong. In early days slaves were held among the Puritans of New England as well as among the people of the South. In the North, however, slave labor did not pay. To get a living from the soil demanded hard, steady work, for which the slaves were not fit. A slave ate as much as a white man, and wasted much more. In the northern states it was actually more profitable to hire a white man than to own a slave. Hence slavery did not long survive.

In the South, on the contrary, slavery was profitable. The white man was not at his best because of the long summer. A slave, however, could do more than in the North because there was no severe winter to hinder him. In the southern climate even the labor of an inefficient slave furnished more than enough to feed himself and his family, and the work of other members of the family swelled the profit to the owner.

This was especially true when the prices of tobacco and cotton were high. Therefore, in the South slavery persisted.

While slavery thus became entrenched in the South the world was gradually becoming convinced that human slavery is wrong. This conviction easily spread in the North. It failed to make headway in the South because the Southerners, like people everywhere, thought that methods which were profitable to them must be right. Hence for a time anti-slavery and pro-slavery dominated the politics of the whole country and finally brought on the Civil War. That terrible struggle would never have occurred but for the marked climatic contrast between the North and the South. Even today the political divergence arising from the difference in climate between the North and the South still persists in the fact that the Democrats count on the vote of the "solid South," while the chief strength of the Republicans is in the North.

How Geography Dominates the Tariff Question in American Politics. Many people suppose that they believe in free trade or protection because of principles of general justice. The vast majority, however, hold one belief or the other simply because of the place where they live, the occupation that they follow, or the way their parents happen to have voted.

As a congressman once put it: "We are not patriots in our treatment of the tariff. We forget the good of the country as a whole, and think only of what products we want free or protected because of the geographical conditions in our particular part of the country." The following examples of things that have actually happened in Congress when a tariff bill has been under discussion illustrate his words. (1) A Massachusetts Republican, although belonging to the party that advocates protection, demanded that hides be placed on the free list. He came from a shoe-manufacturing region. At the same time a Texas Democrat, whose party inclines to free trade, insisted that the duty on hides be increased. The plains of Texas are excellent for cattle, and a high duty on hides would increase the price of their skins. (2) A South Carolina Democrat demanded a protective duty on rice. (3) When the tariff on sugar was reduced by the Democrats the Louisiana Democrats and the Michigan Republicans, representing cane sugar and beet sugar, united in opposing the measure tooth and nail. (4) Senators from the Rocky Mountains dwelt upon the importance of protection of wool. (5) The representatives from California demanded protection of lemons. (6) Minerals have the same effect as plants and animals, for when the Republicans voted for free coal, a Pennsylvania Republican declared that this was a repudiation by his party of its policy of protection.

In general, each part of the country wants protection and high prices for the things that it produces, and free trade and low prices for the things

which it must bring from elsewhere. Manufacturers generally want a tariff on manufactured goods and free trade for raw materials and food. The rich agricultural states of the Mississippi Valley generally want low duties on manufactured goods and high duties on food. Today their demands have shifted to a policy whereby the government guarantees agricultural prices, purchases surplus products, or in some other way helps the farmer in the same way that tariffs help manufacturers. The southern states in general favor free trade because they bring practically all their manufactured goods from a distance, and produce little that would be imported even under free trade. On the other hand, free trade would not lower and might even raise the price of their two large export crops, cotton and tobacco.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Prepare maps showing the present boundaries of European countries compared with those of 1913 and 1937. Discuss the geographical conditions which determined the location of each new boundary. Show the effect of (*a*) mountains; (*b*) distribution of races; (*c*) routes of transportation; (*d*) arbitrary exercise of power; (*e*) mineral resources.

2. Look up the climatic graph for Vladivostok (A113) and point out what features of it have had an effect on international relations and how.

3. On an outline map of European Russia and Siberia, color the coasts which are icebound in winter. Insert the trans-Siberian and trans-Caucasian railways with their main branches and connections to foreign countries. Draw lines along the four most feasible routes by which Russia and Siberia might find outlets to the ocean on the south. Describe each route from the following points of view: (*a*) topography; (*b*) climate; (*c*) location in respect to well-settled parts of the Russian Empire; (*d*) difficulty of building and operating lines of communication; (*e*) international relations.

4. It has been said that the great area covered by the United States prevents real community of interest. Prepare both pros and cons for a debate on this question.

CHAPTER XXVII

POLITICAL RELATIONS OF RELIEF, SEA POWER, AND BOUNDARIES

The Influence of Relief

(1) *The Appalachian Highland.* Let us now look at the way in which certain specific factors in the geographical environment influence political relationships. Although the main line of cleavage between the states in the American Civil War was climatic, a minor cleavage arose from the relief of the land. Within the South the relief of the Appalachian Mountains caused a split between the highlands and the lowlands. The highlanders, by reason of their geographical surroundings, were poor and scattered, and their farms were small and unproductive. They could not work slaves in gangs, raising large amounts of money-making cotton and tobacco. Hence slave labor did not pay. Therefore throughout the Appalachian region from West Virginia southward the mountaineers did not agree with the slave-owning plainsmen, and did not wish to secede. Many of them joined the Northern army, and the great majority welcomed the coming of Northern troops. Today these regions tend to vote the Republican ticket.

(2) *Belgium as a Victim of Relief and Location.* Belgium illustrates the effect of relief in quite a different way. Because that country is located between Germany and France and is at the same time a region of gentle relief with rough highlands to the southeast it has often been a battleground. Belgium's location at the narrowest part of the European plain led the Spaniards to hold the country a long time in the seventeenth century. For the same reason the battle of Waterloo, where Napoleon fell, was fought on Belgium territory. Again in 1914 and 1940 Germany sent its armies across this little country. It was far easier for troops to move there than to advance across the rough plateaus farther south. Thus in a war with which it had little or nothing to do Belgium suffered as much as any of the chief parties to the quarrel except northern France. It lost an enormous quantity of machinery and treasure; its factories were ruined, and its material progress set back for decades.

(3) *How Relief Complicates the Balkan Problem.* On a map of the Balkans notice the numerous mountain ranges, and the many directions in which they run. Between them lie numerous plains, some of considerable

size like those of eastern Rumelia in Bulgaria, and others mere little pockets among the mountains.

Into this region have come many sorts of people. Some, such as the Turks, have found a resting-place here when want and famine, or hostile invasions, caused them to migrate from Asia to Europe. Others, such as the Yugoslavs, have been forced out of the plains of eastern Europe by similar causes. Thus Montenegrins, Albanians, Serbians, Greeks, Bulgarians, Turks, Wallachs, and Rumanians are inextricably mixed. In a broad plain these people might gradually have become more or less unified as have the races from which sprang the English or the French. Each little valley or plain in the Balkan Peninsula, however, is more or less isolated by a mountain wall, so that the various races preserve their own linguistic, social, political, and religious characteristics. Consequently they engage in almost continual quarrels. In addition to this, all alike have been discontented because of the poverty which generally prevails among mountains, and have been inclined to attribute their troubles to their neighbors or to the government.

For all these reasons the Balkans have always played a troublesome role in Europe. The Turks, when they were in power, abused and massacred the Christians until the Christians appealed to the powers of Europe for protection. When the Christians became supreme, they often ill-treated the Turks. Moreover, the Christians have abused one another most cruelly because of differences in creed, language, and race. First one great power, then another, and finally all together have tried to bring order out of the Balkan chaos, but always the mountains and the conditions which go with them have baffled such attempts. The old Austrian Empire took possession of the provinces of Bosnia and Hercegovina and gave them a stable though repressive government, but the mountaineers did not like foreign rule, and the Serbs of Serbia were continually inciting their fellow Serbs of the Austrian provinces against the government. Trouble of this kind in 1914 was the immediate spark which started the first World War, although other and deeper factors were still more important. When Austria demanded a reckoning with Serbia the Russians stood by that little Balkan country, and thus the great conflict was precipitated. Today the Balkan countries are still dissatisfied. Bulgaria wants back the Dobruja on the coast of the Black Sea. Rumania holds much territory claimed by Hungary. In Yugoslavia the Serbs and the Croats are continually quarreling.

Political Rivalries Due to the Sea

Russia's Efforts to Gain a Good Sea Frontage. The sea creates political problems quite as serious as those due to the relief of the land. Russia

has long suffered because of her poor access to the sea. The handicap thus imposed was greatly increased when she lost Estonia, Latvia, and Lithuania at the end of the first World War. From that time until 1939 Russia's only *western oceanic outlet* was at Leningrad. That port, however, suffers from a twofold disadvantage. First, it is icebound from three to five months or more in winter. Second, all the commerce bound from there to the open ocean must pass through the narrow straits at the western end of the Baltic, which can easily be blocked by an enemy. During the first World War Germany closed the Baltic completely to Russian commerce. When the second World War began, the Russians saw their chance to get a better oceanic outlet in the west. Accordingly as soon as Stalin had made his famous agreement with Hitler and had overrun Poland with his armies, he turned to the Baltic States. One by one he forced Lithuania, Latvia, and Estonia to hand over seaports and islands so that Russia might have ports which are frozen only a short time each winter.

Russia's next step in getting control of the sea was more difficult. She demanded that Finland give her certain seaports and the Åland Islands between Finland and Sweden. When Finland refused to do this, the northern oceanic outlets of both Russia and Finland began to be important. The vast *northern* coast of Europe and Asia is practically useless in times of peace. During the first World War, however, the closing of the Baltic by Germany compelled Russia to use the western part of her bleak northern coasts. Since Archangel is icebound more than half the year, a railway was built to the far northern port of Murmansk which is far enough west to be kept open by the warm waters of the North Atlantic Drift. The importance of both ports vanished with the return of peace, but the Murmansk railroad again became important when Russia tried to enforce her demands by invading Finland. Notice how the railroad runs parallel to the eastern border of Finland. From it as a base Russian troops tried to drive straight across the narrowest part of Finland, the "waist," and cut the country in two. Finland's own Arctic port of Petsamo also became important because the war with Germany made it the only place where British and other foreign ships could reach Finland. In the end Finland was defeated because its small size made it no match for the huge Soviet Republic. Then the Soviet government insisted on taking islands and ports in southern Finland as well as a strip of territory along Finland's eastern frontier to protect the Murmansk railway. In addition it insisted that Finland build a railway across its narrow "waist," and give the Russians the privilege of unhampered transportation across the country to Norway and the Atlantic Coast where the Atlantic Drift prevents the water from ever being frozen.

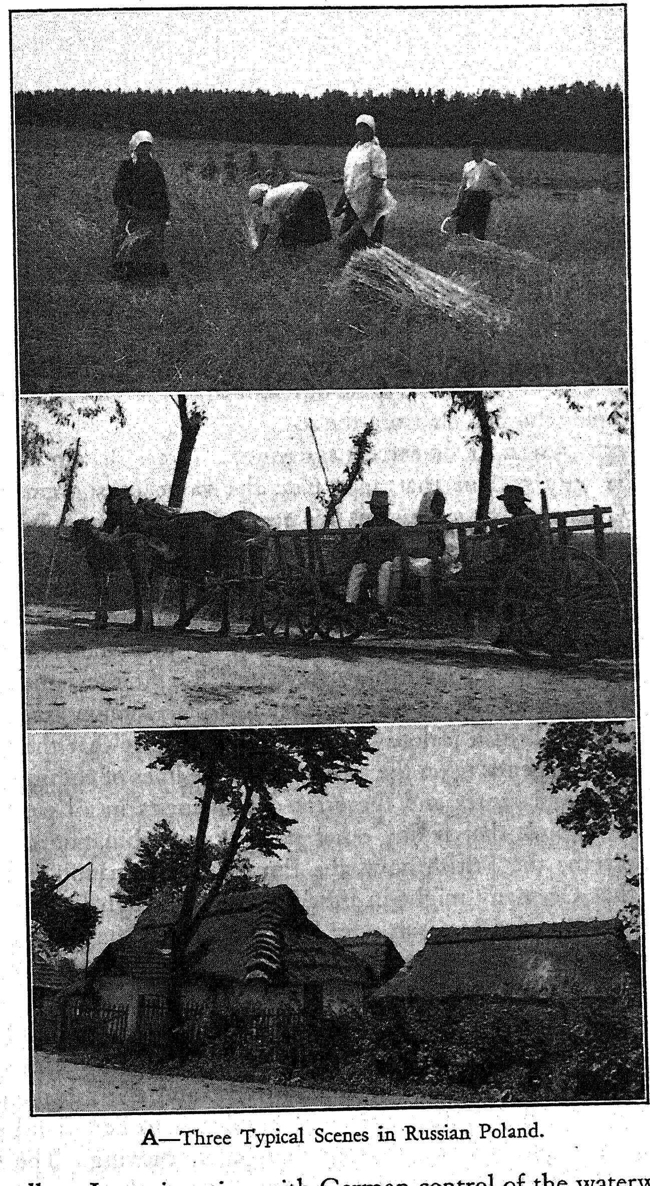
On the *east,* that is, on the Pacific Coast of Siberia, Russia is hampered only a little less than on the north. Even as far south as Vladivostok the ports are troubled by ice for four or more months in the winter, and commerce is impeded. Therefore in 1895 Russia obtained from China the right to build a railroad through Manchuria,* and to hold an ice-free outlet to the open sea at Port Arthur. She held this desirable harbor only a few years, for Japan had long coveted it and was desirous of asserting her influence in the northern parts of China. Accordingly, Japan declared war and expelled Russia from the coast of southern Manchuria, and now has purchased the whole Manchurian Railroad. Russia has had to be content with this, but ever since the Russo-Japanese War there has been friction between the two countries over the right granted to the Japanese to fish in Russian waters from Sakhalin Island.

On the *south* Russia's only outlet to the open ocean is through the narrow strait of the Bosporus at Constantinople. In the old days, inasmuch as the Turks held Constantinople (Istanbul) and there seemed scant prospect of obtaining a free outlet there, the Russians again and again considered the project of an advance across Persia or Afghanistan in order to reach the Persian Gulf or the Arabian Sea. They never succeeded, partly because of England's strenuous diplomatic opposition, but also because the deserts and mountains of Persia are serious obstacles to railroads. Russia's inability to gain a desirable seacoast, and her consequent isolation from her allies during the first World War, were great factors in her collapse and in the spread of Bolshevism. At the outbreak of the second World War, Turkey was inclined to be friendly with Russia. Fear that Russia would want Constantinople, however, was so strong a political factor that Turkey swung to the Allies until the time when Germany seemed to be winning.

England's Relation to the Sea. THE RIVALRY OF ENGLAND AND RUSSIA IN WATERS OF SOUTHWESTERN ASIA. England has generally opposed Russia's plans to reach a favorable seacoast because their success might threaten British rule in India. For a long time England feared that war might arise with Russia. If that happened a strong Russian fleet coming from the Black Sea, or from a good base on the Persian coast, might close the Suez route, cutting England's communication with India and crippling the British Empire. For that reason England for many years supported Turkey, and insisted that Russia and the other great powers sign a treaty which agreed that in time of war the Bosporus and Dardanelles should generally remain closed to the passage of all warships except those of Turkey. For the same reason England used every possible means to strengthen her influence in Persia. The first World War freed England

* Now called Manchukuo since its conquest by Japan.

from all fear of Russia by sea. The second World War again aroused in Britain great fear that Russia and Germany between them would somehow get possession of Istanbul and of the straits of the Bosporus and



A—Three Typical Scenes in Russian Poland.

Dardanelles. In conjunction with German control of the waterway of the Danube, this would have given them almost complete power over Ru-

mania, Bulgaria, and even Hungary, together with large power over Yugoslavia.

HOW ENGLAND'S RELATION TO THE SEA HAS SPREAD BRITISH INVESTMENTS WORLDWIDE. England's relation to Russia is only one phase of her interest in sea power. Her activity by sea not only gave Great Britain the greatest colonial empire, but has also led the British to make investments in every corner of the world. Before other great nations were able to do so, her ships were ready to carry the world's trade and thereby build up great fortunes from the profits on freight. Because Britain had surplus capital from those sources and from her manufactures, and also because her abundant means of communication by sea kept her in touch with all parts of the world, British capital has been invested in all kinds of enterprises from Cape Horn to Alaska and from New Zealand to Norway. These investments keep her permanently interested not only in her colonies, but also in other parts of the world, thus giving the British a broad interest in world politics quite different from the provincial interests of most people who live far from the sea.

GERMANY'S CHALLENGE OF BRITISH SEA POWER. Great Britain and Russia are not the only nations that appreciate the value of supremacy upon the sea. Germany's eagerness in this respect was a factor in the first World War. Cramped and overcrowded conditions in Germany because of the rapid growth of population and the limitations of the frontiers led the whole country to agree with the far-seeing Bismarck when he said, "The future of Germany lies upon the sea." A great merchant marine was rapidly built, and a large navy to protect it. At the same time an attempt was made to obtain colonies and to foster foreign trade. Such activities aroused British jealousy. The English believe that the strength of their empire depends upon the protection of the lines of communication between the island center and the great dependencies in all parts of the world. They think that if any other power or combination of powers should overcome the British navy, the Empire would crumble to pieces. The fear that Germany might in time be strong enough to bring about such a result was also a reason why England insisted on maintaining a navy equal to those of any other two powers. She kept this up until the United States began to build a large navy.

In the second World War naval power was even more important than in the first. Germany's main aim was to starve Britain by using submarines and airplanes to destroy the British navy and the merchant ships which brought food, raw materials, and munitions to her island enemy. Britain's greatest attempt was to keep ships safely moving. The United States felt that the dangers to shipping were so great that our ships were kept out of the war zone. One of the main reasons why we entered the

first World War was that the freedom of our ships to sail the seas was destroyed. In the second World War we gave up that right, an event of major political significance.

The Ownership of Minerals as a Political Problem

The international aspects of minerals, and their effect on world politics and wars, were discussed in Chapter XIV, but minerals also have an effect upon the internal politics of a country. In countries such as England the owner of land is supposed to own everything from the surface down to the center of the earth. In other places, such as many of our western states, he owns the soil, the water, the stones, and all the rights needed for agriculture, house-building, or other ordinary pursuits, but does not own the minerals that are extracted by mining. They belong to the government, which gives them to anyone who discovers their presence and files the proper claims. In still other regions such as Argentina, Italy, Germany, and Mexico, the minerals belong to the state, and can be mined only on proper payment to the government.

Many thoughtful people think that in our own country this last system should be followed. They believe it is not right that a man should make millions simply because he happens to inherit or find a mineral deposit, while another who works harder and with much more intelligence makes only a fair living. Hence our government has withdrawn large areas of mineral lands, that is, it has said that for the present they shall not be granted to individuals. In both this country and England there has been much agitation for the nationalization of the coal mines. The supporters of this idea say that minerals such as coal and petroleum are so important and so easily exhausted that the state ought to guard them. Others say that government ownership would be unjust and would cause the mines to be worked inefficiently and wastefully. Some people take a middle ground and say that the best plan is for the government to own the mines but allow private companies to operate them on the payment of a royalty or percentage of the profit. These differing views cause the ownership of minerals to be an important political question not only in the United States, but in England and elsewhere.

The Relation of Geography to Political Boundaries

Types of Political Boundaries. Many of the most serious political problems arise from international boundaries. The second World War started with Germany's attempt to include all Germans within her boundaries, and to put an end to the troublesome boundaries of the so-called Polish Corridor. Many political boundaries depend on land forms, water bodies, soil, minerals, climate, vegetation, and even on the distribution of

animals. Many others depend on the distribution of races, languages, and religions, or upon the ability of strong countries to take territory away from weak ones.

Mountains form an especially good kind of boundary, but unfortunately other conditions often prevent them from being used. Here are some of the advantages of mountain boundaries: (1) They form barriers which naturally separate the people on the two sides; (2) a mountain boundary usually lies in unoccupied lands which have no great value; (3) the crest of a mountain range is usually well defined, so that there is little question as to where the boundary lies; (4) such a boundary is not subject to changes like those of rivers.

Spain furnishes one of the best examples of the political value of mountain boundaries. The Pyrenees, which cut it off from the rest of Europe, are so hard to cross that throughout much of its history Spain has been quite separate from central Europe. The mountains were one of the reasons why Spain played so little part in the first World War. Italy, also, is cut off from the rest of Europe by the Alps. Accordingly no armies except those of two of the world's most daring generals, Hannibal and Napoleon, have ever crossed the main chain of the Alps. Only at either end where the Alps descend to mere foothills can they be crossed with comparative ease, and even there the railroads need tunnels. Yet in the past armies from France, and especially Austria, have sometimes gone this way to Italy. Norway and Sweden, Spain and Portugal, and India and Tibet are other examples of countries separated by mountains.

Deserts also form good boundaries. Although they do not provide any such definite line as do mountains, they provide wide areas that are of little value, and thus they keep nations apart and prevent wars. Rivers are good boundaries as long as people cannot cross them easily. When they are spanned by bridges or crossed by ferries, however, they become poor boundaries. They are likely to lie in densely populated regions where the people on the two sides have much to do with each other.

The best of all international boundaries are large bodies of water. They are good because (1) they are unmistakable and permanent; (2) they usually coincide with human boundaries of race, language, religion, and so forth; (3) they are not complicated by such factors as the presence of minerals or good land across which the boundary cuts. Oceans provide far more miles of boundaries than do any other geographical features. A country with long oceanic boundaries is fortunate. Great Britain, Japan, France, Italy, Greece, India, Cuba, Denmark, the United States, and Canada enjoy this kind of advantage.

How Good Political Boundaries May be Bad Commercially. It is important to realize clearly that the *political* effects produced by geographi-

cal conditions may be good, while the *commercial* effects may be decidedly bad. For example, politically a country is fortunate if its boundaries are sharply defined by high mountains and are not easily crossed. Commercially such boundaries are unfortunate, for they hamper transportation and trade. India and China illustrate the matter. They are separated by the great barrier of the Himalayas and various other mountain ranges. This has been an advantage politically because it has prevented wars. It has been a great disadvantage commercially for it has almost prevented commerce. It has also limited the interchange of ideas and has thus hampered the progress of civilization.

Why Artificial Boundaries Are a Disadvantage. Wherever international boundaries fail to coincide with natural barriers, trouble is likely to ensue. For example, the southern boundary of the United States is marked in part by the Rio Grande, but farther west it traverses the open plateau. Even the Rio Grande loses its value as a barrier in dry weather, for then it can easily be forded at many points. The rest of the boundary is marked only by pillars set so that one can be seen from the other. Only in part is it followed by a high barbed-wide fence built in order to prevent cattle from straying or being driven across the boundary in defiance of the customs regulations. When Mexico is in commotion, as frequently happens, there is nothing aside from a shallow river or an occasional fence to prevent armed raiders from crossing into the United States. In 1916 a notorious raid of this kind occurred at Columbus, N. M. American civilians and soldiers were killed by Mexican bandits. American troops were sent into Mexico and stayed for months, and war between the two countries was averted only with great difficulty. In times of peace great quantities of alcoholic liquor and thousands of prohibited immigrants are "bootlegged" across such boundaries from both Mexico and Canada.

Unfortified Boundaries. The most effective method of avoiding trouble along an international boundary, especially where there is no natural barrier, is that upon which the United States and Canada have agreed. From the Great Lakes westward the boundary crosses plains, mountains, and rivers regardless of natural features. There, and in parts of New York and New England, it is as easy to cross the border as to travel within either country. Fortunately, the friendship due to similarity in race, language, and ideals, has led Canada and the United States to agree never to fortify the boundary or make any preparation for military activity along its course. This agreement is rigidly carried out, yet frequently small disturbances occur because of the ease with which the border can be crossed. During the Civil War, for example, Canadian sympathizers with the Southern Confederacy tried to organize an armed

expedition to invade the northern states from Canada. Early in the first World War, half a century later, German sympathizers from the United States crossed the boundary and tried to injure Canada by blowing up the Welland Canal. In later years the ease with which the Canadian border can be crossed was one of the greatest obstacles to the enforcement of the prohibition and the immigration laws of the United States.

Sweden and Norway furnish another example of unfortified boundaries. They have agreed that a strip within 15 kilometers on either side of the international boundary shall form a "buffer zone" wherein neither power will erect fortifications. The same sort of agreement has been entered into between Siam and Burma.

How Germany's Frontiers Helped Start Two World Wars. Among the world's great nations Germany has politically the most unfortunate boundaries. An understanding of them helps to explain some of the causes of the two great wars of the present century. The really bad sections of Germany's boundaries are on the east and west. The eastern boundary crosses a featureless plain, while the Dutch boundary on the west is similar, though swampy. Before the first World War the boundary toward Belgium and France lay mostly in a region of low hills easily traversed. Commercially such boundaries would have been good were it not that they gave Germany the mouths of the Niemen and Vistula Rivers which naturally belonged to Russia, and cut Germany off from the mouth of her most important river, the Rhine, where the chief German seaport would naturally be located.

The indefinite character of her eastern and western boundaries was one reason why Germany encroached on her neighbors. In the eighteenth century she annexed part of Poland, and in the nineteenth took Alsace-Lorraine from France. France naturally wanted to recover Alsace-Lorraine, for that section is rich in iron and the majority of the people were French in sympathies. Except along the Vosges Mountains in southern Alsace there are no physical boundaries to separate this region from France any more than from Germany. Therefore both countries felt obliged to provide military defenses along Germany's western boundary. In the same way on the east Russia and Germany were not physically separated. Before the first World War they had no agreement like that between the United States and Canada. Moreover such an agreement was difficult because the two countries differed greatly not only in language and habits, but also in ideals and purposes. Each was constantly afraid of encroachment by the other.

Even in times of peace the absence of any distinct barriers on the east and west of Germany caused difficulties. The Poles by the hundred thousand went from Russian Poland into eastern Germany and took the

place of German workmen who had moved west to the great manufacturing districts or migrated to America. Thousands of Germans went into the Baltic provinces of Russia and there became a dominant force. These things made Germany feel that her power was declining in the southeastern part of her own country, while at the same time she was losing her own citizens elsewhere. On the west the Germans felt hampered and hemmed in because the great volume of foreign commerce that came down the Rhine had to pass through the hands of the Dutch, who control the lower Rhine. In the same way the Belgians profited because much of Germany's foreign commerce passed through their territory. The discontent caused by these conditions was one reason why Germany was so ready to go to war in 1914.

Character of Boundaries in Central Europe after the First World War. From the purely physical standpoint the boundaries of central Europe after the Treaty of Versailles were little better than the old ones. Germany's boundaries had the same disadvantages as before, and some new ones. The Rhine, indeed, is geographically far less of a barrier than the Vosges Mountains. On the east the German boundary everywhere traversed a level plain and could easily be crossed at any point. The only advantage was that the new boundaries satisfied the racial aspirations of more people than did the old, but there were still plenty of racial minorities included in countries where they did not want to be. Among the new disadvantages, one of the worst was the Polish Corridor along the Vistula River and the separation of East Prussia and Danzig from the rest of Germany. The Germans felt more indignant about this than about their loss of territory at any of the other three corners of the country. They also objected strongly to being forbidden to unite with Austria, and to having two or three million Germans included in Czechoslovakia. The attempt to change these conditions was a major factor leading to the second World War.

Poland's boundaries as settled at Versailles in 1919 were politically even worse than Germany's. Poland was carved out of an open plain. In fact, the lack of any barriers between Poland and her neighbors had been one of the main reasons why the old Poland of a century ago was divided between Germany, Austria, and Russia, and the same mistake was made again. The lack of barrier boundaries may have fostered Poland's foreign trade, but it left that country completely open to attack from both Germany and Russia in 1939. The little Baltic states of Lithuania, Latvia, and Estonia dared not resist Russian aggression at that time not only because they were so small, but also because their plains offered no natural boundaries to protect them.

Geographical Nature of the Monroe Doctrine

In the New World the Monroe Doctrine is a conspicuous example of the effect of geography on politics. According to this doctrine no nation outside of America is allowed to obtain new territory in the Western Hemisphere or to establish a new government over any part of it. The United States took the lead in this movement of America for the Americans partly because this country is located in the most stimulating climate of the New World. We were able to maintain it partly because the wide Atlantic separates the Americas from Europe. The Monroe Doctrine was first declared in 1823 when the South American countries had revolted from Spain and were establishing republics. At that time there was danger that European countries would take possession of South America as they later took possession of Africa. The United States did not wish this, for the people here believed in self-government and wanted the South Americans to have an opportunity to try it for themselves.

If South America had been as close to Europe as Africa is, this country could not have prevented England, Germany, France, and other European powers from taking parts of Latin America. So much time, expense, and danger, however, were then involved in transporting an army across the sea that no European power thought it worth while to risk war with us in order to obtain colonies. Thus Latin America was left to try its own experiments in self-government.

QUESTIONS, EXERCISES, AND PROBLEMS

1. On an outline map of the United States, color all the boundaries, both state and national, according to the following scheme: (*a*) boundaries determined by mountains—red; (*b*) by water—blue; (*c*) by deserts—yellow; (*d*) by arbitrary lines of latitude and longitude or other straight lines—green. Discuss your map to show what parts of the country are characterized by each kind of boundaries, and why.

2. Make a boundary map of Europe like the one for the United States described in exercise 1, and discuss it in the same way. Write out a statement of the chief points of contrast between the maps of the United States and Europe, and their reasons.

CHAPTER XXVIII

INTERNATIONAL RELATIONS

Controlling Factors in International Relations

The relations between one country and another depend largely upon the desire of each country to accomplish the following purposes: (1) to find markets for its own products; (2) to purchase commodities which it does not produce; (3) to find homes for its surplus population; (4) to find opportunities for its people to invest capital or otherwise make a living away from home without losing their own citizenship; (5) to protect or otherwise help people of its own race, language, religion, or culture in other countries; (6) to protect itself from aggression; (7) to establish cultural relations through travel and the exchange of all sorts of ideas. In the pursuit of these objectives every energetic country tends to expand its sphere of influence. Sometimes this expansion is commercial; sometimes it consists of sending out settlers to regions which have a different political allegiance; and sometimes it takes the form of taking possession of new territories. All three processes often go on together. The countries which have the greatest energy, that is, those of the cyclonic regions, are by far the most active in all this. Those that have seacoasts, especially coasts bordering directly on the main oceans, also tend to be especially active, because they have the best chance to reach other parts of the world.

The degree to which this process of expansion creates friction with other countries depends largely upon geographical conditions. If a country has large undeveloped areas of its own, it is less likely to interfere with other countries, as is the case with the United States, Canada, and Argentina. If it can take possession of new territories across the sea as fast as it needs them, it is well content to leave its neighbors alone. This was the situation in Great Britain during the nineteenth century. If a country is hemmed in so that it cannot expand, and there are no backward overseas territories of which it can take possession, as in the case of Germany, it is likely to make trouble.

Colonies and Empires

Because of this desire for expansion the course of history has been full of cases where strong nations have spread their power over weak

ones, or over parts of the world that were not well organized politically. Egypt, Persia, Greece under Alexander, and the Roman Empire all illustrate this. At certain periods China has expanded enormously. In modern times the British Empire is the most outstanding illustration, but all the great powers and some small ones also illustrate the matter. The following list of countries which own colonies in other parts of the world is interesting in this respect. It shows the extent to which the countries of the world controlled outlying possessions before the second World War.

Countries	Central Country		Outlying Possessions, Dominions, etc.	
	Area, square miles	Population (thousands)	Area, square miles (thousands)	Population (thousands)
I. North Sea				
1. Great Britain	94,600	46,800	13,261	460,000
2. France	212,700	42,000	4,618	65,000
3. Belgium	11,800	8,500	930	13,500
4. Netherlands	12,700	8,700	790	63,000
5. Denmark	17,000	3,800	122*	41*
6. Norway	124,600	2,900	24†	2.5†
Total	473,400	112,700	19,745	601,543.5
II. Other European				
7. Italy	119,700	43,000	1,223	10,200
8. Spain	194,000	23,500	132	1,500
9. Portugal	34,500	7,300	810	9,200
Total	348,200	73,800	2,155	20,900
III. Non-European				
10. Soviet Republic	6,589,000	147,000	1,507	24,000
11. United States	2,974,000	127,000	712	15,000
12. Japan	147,600	71,000	609	64,000
13. 19-century China	1,459,000	411,000	3,021	97,000

* Faröe Islands and ice-free part of Greenland.
† Spitzbergen and other islands, winter population.

One of the remarkable features of this list is that half of the countries which now own outlying possessions border the North Sea. Little Denmark and Norway, to be sure, possess nothing but cold northern islands, with a very scanty population. The essential point, however, is that they possess certain qualities, either geographical or racial, which have made them spread their political power beyond their own borders. The Netherlands and Belgium, although small, have large and populous colonies, capable of producing great wealth. Great Britain and France go far

ahead of all other countries as possessors of colonies. Only Germany among the North Sea countries fails to be represented.

Another way of looking at the matter is to inquire how far the world's colonial possessions belong to the seven great powers. Here, again, all except Germany are represented. Italy's possessions are not so good as those of Great Britain and France, as is evident from their small population in comparison with their area, but they are of considerable size. The Soviet Republic owns an enormous territory, but it is hard to say how much should be counted as colonial possessions and how much as truly Russian. In the table the republics of the Caucasus and Central Asia have been counted as colonial because independent governments were there displaced by Russia.

The United States might have held vast colonial possessions in the West Indies and the rest of Latin America if it had so desired. As things now stand the table shows Alaska, Puerto Rico, and the Philippines as the country's main outlying possessions, but the inclusion of the Philippines is only temporary. Finally Japan ranks with the Netherlands and France in the number of people whom it controls in conquered or annexed territory. If we include not only Chosen, Manchukuo, Formosa, and various islands, but also parts of China now dominated by Japan, the Japanese colonial figures become much larger. The fact that Germany alone of the great powers is not included in the table is a weighty matter in any attempt to explain the World Wars. Even before the first World War, although Germany's outlying possessions had an area of 1,140,000, they had a population of only 13 million.

Aside from North Sea countries and great powers the other countries in the preceding table are ones whose days of colonial greatness are gone. China, in its greatest days, held a larger outlying area than any country except Great Britain and France. Spain's colonial possessions, aside from the Canary Islands, are largely desert and of little value. Portugal still holds nearly a million square miles in Africa and the East Indies. Aside from the Azores, Cape Verde, and a few other African islands, however, her colonial territory consists mainly of tropical scrub and savanna. Hence it supports only 11 people per square mile in contrast to 21 in the outlying possessions of the United States, even though Alaska is included, 35 in those of Great Britain in spite of the vast waste areas in Canada and Australia, 80 in those of the Netherlands, and 105 in those of Japan. China, even more than Spain, represents a colonial empire that has crumbled to pieces. On the other hand, Australia and New Zealand might be added to the preceding list because they hold tropical territories as mandates from the League of Nations. Taking the world as a whole all the most progressive nations, aside from Germany, have outlying pos-

sessions unless they are cut off from the open sea, like Sweden and Switzerland, or are so new that they have more than enough to do in developing their own territories, as is true of Argentina and Canada.

Stages of National Development

Our understanding of the expansion of nations will be helped if we think of all nations as in one or another of the four stages discussed by S. van Valkenburg in his *Political Geography*: youth, adolescence, maturity, and old age. A young nation is one that is just starting a new career. It may actually be old in years, but it becomes young if some new circumstance leads it to readjust itself to new boundaries and new methods. Poland and Russia both became new countries at the end of the first World War. Germany was new after the German Empire was formed in 1870. Canada, Argentina, and Australia show another kind of youth; they have not yet fully developed their territory and are too busy at home to care much about what other countries are doing. All young countries are alike in needing to be left alone so that they may quietly develop their resources and become adjusted to their boundaries and their neighbors.

While this adjustment is taking place, or when it is finished, some new circumstance may gradually or suddenly throw a country into adolescence. The chief characteristic of adolescent countries is that they are dissatisfied and want to expand. They want new markets, new places for colonization, new sources of raw materials, and new territory outside their own boundaries. This is what happened prematurely to Soviet Russia when Stalin suddenly tried to gain control of all the little countries on Russia's western frontier in 1939. It happened more slowly to Germany prior to 1914. Old countries, too, may be thrown into the adolescent stage by new discoveries, inventions, or ideas. Spain and Portugal acquired adolescent vigor when the discovery of the route around Africa and of the New World opened up a vast new field of exploitation. The same thing happened then in England on a smaller scale. It happened there again in the nineteenth century when the steam engine revolutionized both manufacturing and transportation. This led to a marvelous increase in population, and to an eager desire on the part of the British for new markets and new resources.

Adolescence is an uncomfortable stage both in people and nations. It leads nations to strive for enlarged boundaries at home and for possessions abroad. It is a potent cause of war. It is the period when dictators and military heroes most easily command a following. Sometimes it produces events which satisfy the ambitions of a country, for the time being at least. Often it leads to disaster and to a new period of imma-

turity. In a general way adolescent nations are the "have-nots," the ones who not only want more territory, larger markets, larger resources, but also are actively out to get them.

When an adolescent country has been fairly successful in attaining its aims, or at least has gone as far as it reasonably can in that direction, it settles down into maturity. During the adolescence of the United States we purchased Louisiana and Alaska, quarreled with England about Oregon and Washington, took huge slices of land from Mexico, annexed Hawaii, and ended by taking various islands from Spain. Now, however, we are well content with our boundaries. We are even willing to give up some possessions, such as the Philippines. Great Britain is similarly mature. Its vast empire contains all manner of resources, and these are available for the home country and the dominions as long as Britain remains master of the sea. France, the Netherlands, and Belgium are similarly mature, satisfied, and anxious to keep things as they are. Countries such as Sweden and Switzerland feel the same way, not so much because they have all that they want, but because they are comfortable and can see no way of getting more. Their attitude is wholly different from that of countries such as Germany, Italy, Japan, and Russia, all of which were in the adolescent stage when the second World War broke out in 1939.

When old age arrives, a country begins to break up. Spain's loss of her colonies was a sign of old age. So was the break-up of the old Austro-Hungarian Empire at the end of the first World War. China is an outstanding example of an old country which has been crumbling to pieces bit by bit throughout the present century. Turkey, too, was in the old, weak stage, until the first World War stripped off a large part of its territory and left a homogeneous core which forms a vigorous young nation. One reason for old age is that in their adolescence and early maturity nations add to themselves areas which are alien to them in language, religion, ideals, or race. Such alien areas seek self-government or strive to join other political units which are more to their liking.

Geographical Environment and Expansion

The expansion of nations in their adolescent stage is especially sensitive to the influence of geographical environment. The general principle involved is this: when a nation is somehow stimulated to action it often attempts to expand in many directions, or in the wrong direction. Ultimately, by a process of trial and error it discovers the easiest line of expansion and follows that. The ease with which a country can expand depends largely on the geographical environment. Mountains and plains are important in this respect, for it is generally much easier to expand

across plains than across mountains. Deserts act like mountains in holding nations back. The sea, on the other hand, is now the easiest of all lines of expansion, although in ancient times, before there were ships, it was one of the hardest.

More important than any of these physical features are the skill and energy of the people in the adolescent country in contrast to the countries into which expansion may take place. Russia found this to her cost when she fought with Finland in 1939. Of course the bitter weather, with temperatures far below zero, helped Finland. And of course a little nation of 3 million people could scarcely be expected to hold off a nation of 170 million indefinitely. The vital fact, however, is that the Finns possessed a degree of leadership, energy, and forethought for which the Russians were no match. The Russians suffered because during the previous 22 years they had killed or exiled a large part of their leaders. They were also at a disadvantage because at first they used troops from the east and south. Thus to a certain degree the Finns who live in the cyclonic part of the world were competing against Russians from a less-favored geographical region. Practically always, unless there is some great disparity of numbers, the people in the more-favored natural regions excel those from less-favored regions, no matter whether they compete in war, in commerce, or in science. This fact explains many of the most important trends in the expansion of nations. When an adolescent nation directs its attack against people in a more-favored natural region it usually fails. In the long run it expands along the lines of least resistance. The less the resistance the farther it expands. Let us see how this works out in specific cases.

How Britain Expanded across the Sea

The earliest attempts of Britain to expand beyond the limits of the British Isles were connected with efforts to increase the holdings of its early kings in France. Then, as now, however, France had qualities which made it a poor field for territorial expansion on the part of other countries. It was well populated and progressive according to the standards of those times; it was large enough to be a strong national unit; and its people had as much energy as the British. Therefore England lost ground instead of gaining it. The discovery of America and of the route around Africa to India made up for this by opening some entirely new kinds of countries to British enterprise. All these new countries were far inferior to Britain in the mechanical aspects of civilization. All except the northern United States were also inferior in climatic efficiency and in the two greatest mineral resources, coal and iron, although these did not play any part till the nineteenth century.

When Britain turned her attention across the sea, Spain, Portugal, and France were also looking in the same direction. The easiest line of expansion for all these countries was across the Atlantic. In Africa three obstacles presented themselves: (1) the deserts which are characteristic of west coasts; (2) the feverish jungles of the "Guinea Coast" in low latitudes; and (3) the length of the voyage to and around the Cape of Good Hope. Spain and Portugal, in accordance with their geographical position, found their sphere of activity in the low latitudes of America, where the mild climate prevented their colonies from growing great. England and France colonized farther north, where the climate is stimulating. The fact that England is an island, and looks seaward, while France is part of the continent and must constantly keep an eye on its frontiers by land, helped the English to wrest from the French their American possessions across the seas. Thus by far the best part of America became English.

Curiously enough, however, the fact that Britain secured the best part of America had much to do with her loss of that same area. The northern United States embraces most of the only really large section of the world which rivals Western Europe in climate and resources. Thus, when the colonies there grew strong, they were a match for the British, and freed themselves. This is one of the many cases where a great nation has been unable to expand permanently into territory which is geographically equal or superior to its own. Of course the sea voyage and troubles with France put the British at a great disadvantage. It is worth noting, however, that, even though Canada remained as part of the British Empire, it soon followed the example of the United States in managing its own affairs. Energetic people will not tolerate abuses which more apathetic folk put up with for centuries.

In India the effect of geographical conditions upon England's colonial history was not at all the same as in the United States. Soon after the discovery of America, British merchants went to India to engage in trade, and with no purpose of founding a vast Indian Empire. They found a densely populated country whose inhabitants lacked energy because of the tropical climate, and who were correspondingly backward in civilization. Accordingly, for their own convenience and safety, the British merchants assumed control of a small area near Calcutta and governed it. At first they merely took space enough for forts within which to shelter their warehouses and offices. Then, for greater peace of mind, they spread their power over the towns where the forts were located and in time over surrounding districts. But neighboring Indian states troubled them. Sometimes the trouble was due to the aggression of the forceful English traders; sometimes to the dishonesty and treachery of the natives. In either event the strong people from an invigorating climate conquered

the weak tropical people. Thus British rule was spread abroad. The process has continued until England governs over 350 million people in southern Asia.

During the first World War the location of Mesopotamia and Palestine gave England a special interest in those regions. Germany had been getting a foothold in Mesopotamia, and thus bade fair not only to dominate the land route from the Mediterranean to India, but even to threaten the sea route. Turkey, on the other hand, began to threaten the Suez Canal from Palestine. Hence England conquered not only Mesopotamia, using India as her base for supplies and troops, but also Palestine with Egypt as a base. When peace was declared England was left in control of these regions and in a position to carry out her long-cherished plan of a land route of her own from Egypt and the Mediterranean to India. Outside her actual possessions and mandates the influence of England is paramount in Irak, Iran, Afghanistan, and Tibet, because her position in India makes her the nearest strong power to each of them.

In the Southern Hemisphere British expansion followed much the same course as in the Northern. Australia, with its sparse native population and its good climate in the southeast, repeated the history of North America on a small scale, as did New Zealand. Those regions were easy to take possession of, but the European colonists there had so much energy that they soon governed themselves. There was never any revolution, however, because the Australasian colonies did not develop until England had learned the lesson of good colonial government. In South Africa the course of events was midway between that in Australia and India. The British settlers encountered a denser native population and a less-stimulating climate than in Australia. They dominated the natives as in India, and they met and conquered Dutch settlers much as they met the French in Canada. Nevertheless, progress has not been so rapid as in New Zealand, for example. In tropical Africa the conquest of the British colonies took place much as in the later stages of India's history, but the results have been relatively meager. Elsewhere the British colonies are relatively small or unimportant. In Egypt, England acquired a colony because Egypt happens to lie on the highly important route which connects the homeland with India. But in 1922 England gave up her direct control over Egypt except for a canal zone where her position is much like that of the United States in the Panama Canal Zone.

Why the British Empire Has Grown so Great

(*a*) *Britain's Central Location*. The reasons why the British Empire today embraces nearly a quarter of the earth's surface may well be classified according to the table in Chapter I, showing the elements of

geography. The location of Britain off the northwest coast of Europe brings it relatively near the middle latitudes of America and thus led the British to occupy the best part of America. That helps to explain why in the world as a whole English is the most widely used language. The location of Britain in respect to India was also influential in causing the Suez Canal to be dug, and was the reason why England took charge of Egypt and still controls its foreign policy. After Great Britain became imbued with the purpose to build up a great empire she set herself to control the best lines of approach to each of her possessions. This involved picking up islands such as the Bermudas and Falklands, and ports such as Hongkong, all over the world. Today along her most important route leading to India England has secured a whole string of way-stations —Gibraltar, Malta, Cyprus, Suez, Perim, Aden, Socotra, and the Kuria Muria Islands. Britain is the meeting place of the most remarkable network of lines of communication that the world ever knew. She has improved her highly favorable location much as Paris improved hers by building roads and Chicago by railroads.

(*b*) *The Advantage of the Empire's Island Home.* Great Britain is fortunate in being an island, particularly an island with a submerged coast. Had her territory been joined to the mainland, she might perhaps have remained united with France. Certainly her interests would have been directed toward the continent, as have those of France, because of the need of protecting herself from other countries and of maintaining constant intercourse with them. Had her coast not been submerged she would have lacked the hundreds of harbors, great and small, that keep her in touch with the sea. Moreover, when she came in conflict with other nations which were also expanding by sea she had an advantage because her long coast gave her far more sailors and ships than the others had, and also led her people to be interested in commerce and remote overseas ventures in a way that is not possible for an inland country.

(*c*) *How the Ocean Brought Worldwide Expansion.* Being surrounded by water Britain had to expand by sea or not at all. Since she expanded across the water she was able to choose whatever places she preferred with much less hindrance than if she had tried to push this way and that by land. Moreover, the discoveries of Columbus and others presented her with a vast variety of relatively weak countries among which to choose. North and South America, Africa, Australia, and southern Asia were all inhabited by people whose stage of civilization and degree of energy made them no match for the British. Thus the growing British Empire was like a tree which is able to spread its roots widely in soft porous soil. Spain and Portugal were like less vigorous trees pushing their roots into the soil close by, while France and the Netherlands were

hampered by having rocky soil in the shape of the continental countries of Europe on one side of them. Being as energetic as any people in the world, and being much more active on the sea than any others, the British were able to take possession of almost all the best regions in America, Africa, Asia, and Australia. Even when other nations had preceded her, she often drove them out, as happened to Holland in New York and South Africa, to France in Canada, and to Portugal in Ceylon.

(*d*) *How Coal and Iron Aided the Empire's Growth.* In later times the minerals of Britain have been of the first importance in the growth and maintenance of the British Empire. An abundance of cheap coal close to the water enabled Britain to substitute steamships for sailing vessels sooner than any other nation. Then it enabled her to run her ships cheaply and gave her cargoes to take abroad in exchange for bulky foodstuffs and raw materials. Thus coal clinched Britain's control of the sea. So, having picked up an island here, a seaport there, and a whole province somewhere else, she was able to hold them easily. Her iron ore helped equally, for with the coal it enabled her to modernize her manufacturing with steam and machines sooner than any other country. Her manufactures supplied her ships with the most profitable kind of goods for export, and thus were one of the main causes of the growth of the empire. Petroleum is the only important mineral product which neither Britain nor her colonies supply in abundance. For that reason after the first World War some influential Englishmen wanted to retain Persia and part of Transcaucasia in order to control the Baku oil fields. Others, however, felt that such a course was contrary to the spirit embodied in the League of Nations, and that it would be enough if the oil of Iran could be developed by British companies.

(*e*) *How British Energy Turns the Scales.* The climate of England, as we have seen, comes close to being the best in the world. It lets people work and play actively outdoors at all seasons, and thus helps to make them not only healthy, but also tough and sturdy; it stimulates the mind, so that people can think clearly and act energetically. Thus when the British are pitted against other nations their extra energy has again and again turned the scales and enabled them to hold parts of the world against their rivals. One of the main reasons for the strength of the British Empire is that several of the chief colonies have climates which resemble that of England in their stimulating qualities. Southern Canada, New Zealand, and southeastern Australia rank highest. No other country has colonies which approach these in this respect. Their value is evident from the sturdy help that they gave in the World Wars.

(*f*) *How the Need of Food and Raw Materials Encouraged Expansion.* From the point of view of a colonial empire the fact that certain

useful plants and animals cannot grow in the British Isles has played an important part. The search for valuable products such as tea, spices, and silk, as well as gold, led to Britain's first expansion to India and America. In later times, when manufacturing became important, the fact that Britain cannot produce either food or raw materials in sufficient quantity and variety impelled the British still further to expand their empire. The jute and hides of India are far more valuable than all her spices, silk, tea, and precious metals. So, too, the wool and meat of Australia; the wheat, wood, bacon, cheese, and paper of Canada; the cotton of Egypt; the rubber of Ceylon; and the wool of South Africa are the kind of products that make her colonies worth while to Britain. Nevertheless, many thoughtful people doubt whether the possession of all these colonies has really increased the prosperity and happiness of Great Britain. They point to the Scandinavian countries and Switzerland as countries where overseas possessions have had little or no influence, but which rival Great Britain in general comfort, and have not been subjected to the strain of terrible wars.

The Expansion of the United States

Because the United States is a region of high energy and vast resources, and is inhabited by a strong race, the process of expansion has gone on rapidly. We bought Louisiana and Alaska partly because they are located nearer to us than to any other strong power. Hence they were worth more to us than to France or Russia, their previous owners. Two other geographical conditions also entered into the matter, namely, the fact that Louisiana guards the mouth of our greatest waterway, while Alaska is rich in fish and fur. In Texas, Arizona, California, Washington, and Hawaii, location was also a primary factor in causing the expansion of the United States. In Texas, not only the nearness of the region to the rapidly growing eastern parts of the United States, but also the form of the land and the nature of the climate were important. The great plain, continuous with that of Louisiana, invited settlers, while the fitness of the climate and vegetation for cattle raising was a strong attraction. Other parts of the southwest fell into our hands largely because much of them was desert, and the parts that were not desert were so far from Mexico that few Mexicans lived there and misgovernment was rampant. Hence, in spite of much talk, there was little organized opposition in Mexico when they were ceded to this country. Although the whole transaction was to the advantage of Texas and the United States, it was not strictly just. It illustrates the way in which the demands of the energetic people of cyclonic regions are forced upon the weak people of the tropics and the Orient. It must also be remembered that, by reason of its own natural

growth and the addition of settlers from Europe, the United States was rapidly expanding, while Mexico was changing but little. Mexico herself, together with the unfavorable climate, prevented us from expanding southward, while England was firmly established in Canada. Hence the natural direction of expansion was westward. This explains why the settlers of the United States pressed into Washington and Oregon ahead of the British, who claimed those regions because of their fur-trading posts.

Our other acquisitions also illustrate the effect of climatic contrasts and of location. At first our expansion, like that of Russia, was entirely by land, but later we followed England's example and went across the water. First we took the Hawaiian Islands because they are nearer to us than to any other country. Moreover, although not on the short route between this country and Japan and China, they are a port of call for many steamers. For these reasons and also because of their wealth in cattle, sugar, and other tropical products the early Americans there formed a solid nucleus for modern government and we felt obliged to support their aspirations to become part of our union. In Samoa, also, we took action, first because we wanted a naval station in the South Pacific, and then to end misgovernment.

After the war with Spain in 1898 we placed a protectorate over Cuba. Because it lies at our very door we were interested in its sugar crop, and wanted to right its wrongs. Our acquisition of the island possessions of the Philippines and Puerto Rico, however, had little geographic cause except that they are nearer to us than to Spain, and Spain's weakness and corruption were in part of geographical origin. As for Guam, we were glad to get it because of its location where a coaling station was needed if we were to maintain much intercourse with the Philippines. Since then we have from time to time exercised a mild protectorate over Nicaragua, Haiti, and Santo Domingo. Today, however, the adolescent spirit of expansion has given place so fully to maturity that we have promised freedom to the Philippines, given up our protectorate over Cuba, and almost ceased to interfere in the internal affairs of other West Indian and Central American republics.

The Panama Canal Zone and the Virgin Islands, however, fall in a group by themselves. We took Panama from Colombia because we wanted to use our strength in forwarding the great international enterprise of the canal. We bought the Virgin Islands from Denmark because the United States feels that it should not run the risk of letting islands guarding the approaches to Panama fall into unfriendly hands.

The Expansion of France

France is another mature country located in a highly stimulating climate. She, too, has expanded into regions occupied by weaker people, but not in the same way as Great Britain and the United States. Of late she has not had much surplus population with which to establish colonies like those of Britain. Her land frontiers have been bordered by strong countries, so that she could not expand into neighboring territory. Soon after the discovery of America she made her first colonial attempt in the same way as Great Britain. Many of her people settled in Canada, some in Louisiana, and a few in India. These places she lost, chiefly to England, because of the English energy and sea power and because, being a self-supporting agricultural country with little excess population, France did not really need colonies. All that she holds today in these regions is a few tiny bits such as the islands of St. Pierre and Miquelon off Newfoundland, Martinique in the West Indies, and the port of Pondicherry in India. In thus losing her early American and Indian colonies France suffered the same fate as the Netherlands and Portugal.

During the nineteenth century, when the need of raw materials and of markets started all the great countries of Europe on a new hunt for colonies, France again made an attempt. This time she did not expand from her Atlantic Coast where she had failed before and where she would have had to compete with England. Instead she went out from her Mediterranean Coast to Algeria and Tunisia, the nearest land that was not held by a strong nation and hence was weakly governed. Then she expanded into the Sahara and eventually took the bulk of West Africa. Today her possessions in the continent of Africa are twenty times the size of France, while even the island of Madagascar, off the southeast coast, is larger than the home country. Finally the French turned again toward Asia, and entered upon a deliberate plan of conquest in Indo-China. Today England alone has a larger colonial empire, for the French possessions are larger than the United States and have half as great a population. But all this vast area contains scarcely a square mile where the climate is really good, although there are some small fairly good parts in the very north of Africa and in the highlands of Madagascar. Because the French colonies are commercially tributary to the Mediterranean, Marseille is the great colonial port.

The Expansion of Japan

Among the nations of Asia, Japan is the only one which is strong, and the only one which is located in a region of cyclonic storms. The example of other strong nations and the enthusiasm of adolescence made

her believe that colonial possessions would benefit her. The growth of her own population made her feel the need of them. The weak and poorly governed regions of Formosa and Korea, only a little distance from her coasts, gave her the desired opportunity for expansion. They were not enough to satisfy her, however, and as Manchuria was the nearest easily accessible region she rapidly became dominant there. The next step was to attack China. Japan's hope was not only to gain control of China's great coal and iron deposits, but also to establish herself as the maker of most of the manufactured goods used in China. Other nations were to be thrown out, China was to supply raw materials and fuels, and Japan was to support millions of its people by manufacturing.

Japan's expansion is the result of a real need. Not more than one-seventh of her territory can be cultivated; the rest is too mountainous. That seventh, comprising only 21,000 square miles, supports 65 million people, or more than 3,000 to the square mile. As the population increases and the standard of living rises, the Japanese must have new means of support.

Japan's Chinese Problem. It is hard for Westerners to judge Japan fairly, and it is easy to criticize her for breaking treaties and oppressing the Chinese. Without condoning these acts, however, it may be pointed out that Japan's behavior is in harmony with the geographic environment. Japan's expansion is curiously like that of England and the United States except that it came at a later time when the standards of international conduct had risen. Every nation that lives in a relatively stimulating environment tends to expand at the expense of people in less stimulating environments. In the long run, however, commercial penetration appears to be more effective than military conquest and political control as a method of expansion. By cultivating friendly relations a large and profitable trade might be developed between Japan and China. In Japan the geographical conditions cause manufacturing and commerce to be of ever-increasing importance. In China the lower degree of initiative among the people and the presence of great natural resources cause that country to offer vast possibilities as a source of raw materials.

One of the greatest promoters of trade is geographical proximity. Countries that are near together are likely to carry on a lively trade, especially if one supplies food and raw materials and the other supplies manufactured goods. France and Germany prove the power of geographical position, for, even though they are mutually hostile and differ only a little in their products, French trade with Germany before the first World War amounted to as much as the trade of France with all her colonies. In the same way, in proportion to the population Canada does several times as much business with the United States as with Great

Britain. Thus it appears that if Japan could remain on friendly terms with China without political control she might become the chief factor in the trade of that country, and at the same time maintain the world's respect. As things have worked out, however, Japan is finding that the mere size of China is a potent obstacle to complete domination by a foreign power. She finds, too, that the difference in energy between Japanese and Chinese, although real and important, is not enough to give her any such dominance as Britain has long enjoyed in India.

The Expansion of Italy

Italy is no exception to the general rule that at certain stages in its career every great power has the adolescent spirit which makes it eager for expansion. In the scramble of the great powers for Africa in the last century Italy came off poorly. The country had only recently been united under a single government, and it needed time to adjust itself to the new conditions. Nevertheless, it made some feeble attempts to take African territory. It obtained what was left of the south coast of the Mediterranean. France, however, had already taken Algeria and Tunis, the best western parts, and Britain had taken the good eastern part, Egypt. What was left was mainly the Sahara Desert with a poor coastal strip in Libya. Italian Somaliland and Eritrea were almost equally poor, for they were either deserts or lands of poor tropical scrub and savanna. After the first World War Mussolini awakened the adolescent spirit, and Italy began to look around for some weak part of the earth that could be made into a colony. The Monroe Doctrine excluded South America; the rights of other powers or the desert excluded southern Asia and every part of Africa except Ethiopia (Abyssinia). The fact that Ethiopia is such a high, cool, isolated plateau had enabled it to remain independent when all the rest of Africa except Liberia, which we protect, had been taken by the nations of Europe. Inasmuch as Ethiopia lies close to Eritrea and Italian Somaliland, the Italians selected it as their prey.

In these days of mechanized warfare no non-industrial country has a chance when it comes to actual fighting against an industrial country. Although the Abyssinians rank high among Africans for energy and intelligence, they were easily conquered. The real problem for Italy is not the conquest or even the governing of Abyssinia, but whether she can make it pay. Most geographers are doubtful of this. Only a small part of the country has the jungle type of vegetation which indicates fitness for tropical plantations. Even the best parts are not particularly good for white colonization, and they are already densely populated. Even if Ethiopia could supply all the plantation products needed by Italy, which is doubtful, the profit on them, over and above what it would cost

to buy them elsewhere, would be slight. Moreover, the number of Italians who would thus find work would be no more than the growth of population in only a few years. Against this must be set the costs of war in money and lives, and the heavy costs of administration. Such colonies can scarcely be called a paying investment.

The Expansion of Germany

The relation of Germany to its weaker neighbors is different from that of any other country. In the first place, she was so busy with attempts at unifying her own states that she was not ready to look abroad until after 1870. After that she gradually formed the purpose of building up an empire outside Germany. Just as England's ideal has been the formation of a great empire of self-governing dominions, and that of the United States the spread of self-government, so Germany's great ideal was that her special type of culture should dominate the world on land and sea.

Another difference between Germany and the other great powers is that she is the only one that has had no real opportunity to expand either to adjacent territory or to territory lying across neighboring seas. Landward she was hemmed in by France, the Austro-Hungarian Empire, and Russia, all of which were then strong and in the process of expansion. In part she was also hemmed in by the little nations of Denmark, Holland, Belgium, and Switzerland, which, though small, are too energetic to be easy fields for permanent expansion. Before the first World War she did, to be sure, expand a little, absorbing part of Poland, taking Schleswig-Holstein from Denmark, and Alsace-Lorraine from France. This gained her only a small area, however, and increased the difficulty of further expansion by arousing antagonism among her strong, energetic neighbors. Expansion by water to the north then seemed impossible, for Norway and Sweden are as energetic and highly civilized as France and Denmark, and their boundaries are so clearly defined that there can be no possible dispute as to where they lie.

Seaward, in distant and backward parts of the world, Germany also found it difficult to expand. In the early days of the modern colonial movement her continental position did not encourage her people to be worldwide traders like the British. Moreover, the many German states were so late in uniting into a strong empire that when at last Germany was ready to seek colonies most of the available territory had already been claimed by other powers. Yet her population was increasing greatly. German manufactured goods were flooding the world, and the country was eager to expand like the other nations of cyclonic regions. Germany, to be sure, obtained a few colonies, such as German East Africa, German

West Africa, Cameroon, and part of New Guinea, but they were the scraps left over after the best parts had been taken, mainly regions of tropical scrub and savanna, or of dense rainforest in the Cameroons. Hence they did not supply the plantation products which Germany so much desired.

Because of such conditions Germany still felt a strong impulse to expand. She might have done so in several ways, but each presented difficulties. (1) For example, she might have tried to take possession of South American regions such as Brazil, but there the United States with its Monroe Doctrine blocked the way. Germany knew that if she encroached in America, Britain was ready to use her fleet to help the United States, and German prospects would have been blasted at once.

(2) Germany's expansion might have come by crushing one of her neighbors, but that was difficult because all her neighbors are energetic nations living in the cyclonic region of great energy. Moreover, they were largely allied with one another, and the larger nations had agreed to protect the small ones.

(3) Next after South America the region that the Germans most desired as a field for expansion was China. Hence they took Tsingtau on Kiau-Chau Bay, and began to exploit the province of Shantung. They dared not go farther, however, for in those days, before the first World War, England, France, Japan, and Russia all were looking for new territory in China, while the United States was trying to preserve China intact.

(4) Still another possible field of expansion was Turkey, the only remaining large and backward part of the world which no strong nation had yet converted into a colony or at least protected against the aggression of other nations.

(5) German expansion might also have come in the new way fostered by the League of Nations. She might have spread her influence through the peaceful channels of trade, education, science, and friendly intercourse, especially in eastern Europe and Turkey, just as Japan had an opportunity to do in China, and the United States in Mexico and South America.

For this kind of expansion the German prospects were particularly bright, but the process is too slow for an eager nation in the stage of adolescence. Ambitious Germany wanted to achieve world supremacy at a single bound. Therefore she chose the fourth alternative, and began to seek to control Turkey. First she went to work to build the Bagdad Railway, from Constantinople across Asia Minor to Mesopotamia. The water route from Germany to Turkey is long and is at the mercy of England. There is a short and safe land route, however, through Austria and the Balkans. If Germany could control this route together with the

Bagdad Railway she would have a direct land route through the heart of the prize that she coveted. The easiest way to work for this was through the Germans and Magyars of Austria, the strongest elements in the old Austro-Hungarian Empire. Hence Germany combined with these Austrians to gain control of Serbia, through which runs the main railway to Turkey. That helped to bring on the first World War.

During the first three years of that war Germany became supreme not only in the non-German parts of Austria, but also in Serbia, Bulgaria, Rumania, and the Turkish Empire. Thus in three years she carried out an expansion like that which Great Britain, Russia, and the United States had accomplished slowly during many generations. If Germany had accomplished this result by means of peaceful commercial penetration the world would have raised no objections greater than those raised against the expansion of all strong countries. Because she disregarded treaties, as well as for commercial and other reasons, most of the world was against her. Thus she lost not only her recent gains, but also much of her earlier ones in Denmark, Silesia, Poland, and Alsace-Lorraine, and all her foreign colonies.

The result of the first World War was closely in accord with geographical conditions. Germany was defeated by the western nations living in the most bracing cyclonic areas. Wherever she was pitted against nations living in regions less invigorating than her own she was successful. After her defeat on the west she could not remain dominant in the Balkans and Turkey because England, France, and Italy are all interested in those regions and can easy reach them by water. In Central Europe, however, the war left a number of small new nations, including Lithuania, Poland, Czechoslovakia, and Austria, as well as a greatly weakened Russia. The first four adjoin Germany. The Austrians, being Germans in race and language, sympathize with their fellow Germans. The others dislike Germany, but she is the nearest great manufacturing nation, and the one to which they naturally turn for capital, for engineers, and for the many services which less-developed countries constantly seek from those that are most highly developed. The countries bordering Germany on the east stand just enough behind her to look up to her and let her dominate their commerce and industry.

Under conditions such as these the injustices of the Versailles treaty and the leadership of Hitler reawakened in Germany the spirit of revolt against existing conditions and the desire for national expansion. This time, more definitely than before, the effort was directed along strictly geographical lines. After bringing as many German-speaking people as possible within the limits of Germany, the Nazi plan was to make that country the dominant power in the regions to the southeast of it.

The difficulty of westward expansion against France, Belgium, and the Netherlands was recognized, but Poland, Hungary, Yugoslavia, Bulgaria, Rumania, and the Ukraine portion of Russia are of a different caliber. They are largely agricultural, their transportation systems are only moderately developed, and their industrial and commercial activity is decidedly less than that of the North Sea countries. Thus it seemed possible for Germany to dominate their trade and their political connections without actually destroying their existence politically. In fact Germany had little difficulty in taking possession of Austria and Czechoslovakia. The expected results, however, did not follow because Poland did not yield to German threats concerning the Corridor and Danzig, and France and Britain declared war in fulfilment of promises to Poland. This led to the most violent war ever waged. The violence was tremendous because the part of the world with the greatest geographical advantages, aside perhaps from those of the United States, was split into two desperately warring sections. From our present geographical viewpoint the main fact is that Germany is so hemmed in by other great powers, or by nations that are fairly well advanced, that she has extreme difficulty in expanding. Having fought an exhausting war on the west, where the geographical environment most promotes efficiency, she still finds her best field of expansion in the less efficient southeast.

The Physical Environment of Soviet Russia

Just as England furnishes the greatest example of expansion by sea, so Russia furnishes the best example of expansion by land. Compared with the 13 million square miles and 440 million people of the British Empire, Russia before the first World War had 8,600,000 square miles of territory and 180 million people. Yet the Russian Empire has never had the strength and vigor of the British Empire, for Russia is subject to many geographical disadvantages. The history and present problems of the Soviet Republic illustrate so many important geographical points that we shall go back again to the table with which we began on page 4. Following the outline there given we shall summarize the geographical environment and its effect on the people of Russia. This will serve as a summary and review of many points discussed in this book.

I. *The Earth as a Globe.* Soviet Russia has the disadvantage of being located in the worst part of Europe and in an inaccessible part of Asia. Thus it comes in little contact with the world's most progressive countries. It also lies far north, and is so continental that the climate is not appreciably ameliorated by the sea. All but a small fraction lies farther north than any part of the United States. This renders about half of the country too cold for any kind of agriculture. Another quarter, because of its

position far in the interior, is too dry for agriculture except with the help of irrigation, which is possible only in a few limited areas. Thus the area available for agriculture is actually less than in the United States. Then, too, Russia's location, far north and in the interior, makes the land only about half as productive per acre as land in the United States. Better cultivation might improve the situation somewhat, but in no country where similar climatic conditions prevail is the yield per acre much higher than in Russia. Yet in spite of its limited agricultural area and low productivity per acre Soviet Russia supports four times as many farmers as the United States. About 75 per cent of the population is agricultural. Such great density of population, combined with the handicaps of high latitude and extreme continentality, cause the yield of crops per man on the farm in Russia to average only about one seventh or eighth as great as in the United States. In other words, the geographic conditions are such that for many generations the Russian agricultural population can scarcely expect to be anything except extremely poor compared with the United States or Western Europe.

II. *Land Forms.* The form of the land in Russia has helped to spread a single type of culture far and wide. In the great section between the dense northern forests and the southern deserts the vast plain is easily traversed. From Moscow, where the old Russian Empire took its rise, the plain stretches away in every direction. To the north the level land reaches a limit only in the Arctic Ocean, and to the south in the Black Sea and the Caucasus Mountains. Westward the Russian Empire never reached any natural boundary, for before the form of the land changes appreciably, new languages and peoples are found and new conditions of climate and vegetation. Such conditions create an element of weakness. When the old Empire began to crumble, these border regions at once broke into little states such as Finland, the Baltic States, Poland, and Ukraine. The last became a part of the Soviet Republic, but the rest were independent for a while. The boundaries between them and the Soviet Republic lie in the plain and are so indefinite that they are just the sort to make trouble. This is one reason why it was easy for Soviet Russia to invade Poland and to establish control over the three Baltic States in 1939. Eastward the plain is only slightly interrupted by the low Ural Mountains and extends thousands of miles to the plateaus of northern Siberia. Its vast extent is one chief reason why the Russian Empire became so huge.

III. *Bodies of Water.* As we saw in the last chapter, Russia has always been handicapped by her unfortunate *relation to the oceans.* So far as *inland bodies of water* are concerned, however, they have aided her expansion and are still a real help. The navigable Volga is one of the unify-

ing forces. Because Siberia is a plain, the pioneers were able to float down one of its rivers and pole their boats up another, time and again. Such water transportation aided greatly in allowing the Russians to spread easily over northern Asia.

IV. *Soil and Minerals.* Russia's *soil* does not help the country so much as might be expected from its quality. In the Black Earth region of the south (Plate I) Russia has a vast area of the richest soil in the world. Elsewhere, in places such as the region east of Leningrad, it has large areas of poor soil. Yet as a rule the general progress of the country has been greater on the poor soil than on the good. The climate, where the good soil prevails, is so dry that disastrous crop failures are frequent.

One of the most important points in which Russian expansion has differed from that of Britain is the use of *minerals.* In Britain coal and iron are found near together and in the densely populated parts of the country. In Russia, the deposits are not only far less abundant than in England but, aside from the Donetz area in the south, they lie largely on the outer edges, or in sparsely settled areas like the Kuznetsk region far east toward Lake Baikal. Moreover, most of the iron ore has to be brought a long way to the coal, and there is no cheap easy means of transportation like out Great Lakes. For these reasons, and also because Russia is in many respects less advanced than the other great powers, her coal and iron were slow in being developed. Under the Soviet regime, the net result has been merely to raise the production of coal, petroleum, iron, and other minerals to approximately the level that might have been expected if there had been no war and revolution. This is contrary to a widespread belief, but official records and the curves based on them leave little room for doubt. Previous to the first World War Russian industries had been steadily growing. If that growth had continued unchecked, the degree of development would have been practically the same as was actually accomplished by dint of great efforts after all industries had practically disappeared during the revolutionary period from 1917 to 1921.

V. *Climate.* We have already spoken of the climate of Russia, but more needs to be said. Although the entire Soviet Republic is handicapped by the extremes that are inevitable in a highly developed continental climate in high latitudes, the climate deteriorates from west to east. The best climate is found in the Leningrad region, for that is where storms and oceanic influences penetrate farthest inland. From Moscow eastward the climate becomes more and more continental so that the winters are colder and drier, the summers warmer, cyclonic storms less frequent, and the unreliability of the rainfall greater. This is bad for both people and crops. It did indeed help the early Russians to conquer the vast area from the Caspian Sea and Volga River eastward, because it

helped to make the native races inefficient. Now, however, it denies to the Soviet Republic the chance to develop strong colonies like Canada and New Zealand, which in some respects excel their mother country. Starting from Moscow, the early center of the old Russian Empire, the Russians found that on the northeast they soon reached a region too cold for agriculture, and to the southeast a region too dry. Only in a relatively narrow strip to the east is the country favorable, and even this strip grows narrower until it ends at Lake Baikal.

A and B. Plants and Animals. Another disadvantage appears in the plants and animals. England's expansion enabled her to draw on all sorts of new foodstuffs and raw materials. That of Russia in early days, to be sure, brought her the wheatfields of the region north of the Black Sea and of western Siberia, but in both regions the scarcity of winter rain and the frequency of droughts cause the yield per acre to be pitifully low. In later times Russia did indeed acquire the regions now called Turkmenistan, Tajikistan, and Uzbekistan, as well as Transcaucasia south of the Elburz Mountains. There cotton, and many fruits such as the peach and melon, can be raised. It is even possible to raise tea in a small highly protected area between the eastern end of the Black Sea and the Elburz Mountains. Such conditions furnish a stimulus to trade and transportation as well as to agricultural development, but the possibilities are relatively small.

C. Man and His Handicaps. 1. OVERPOPULATION. Some of the greatest handicaps of Russia are overpopulation, low productivity per acre and per man, and scarcity of work in winter. Overpopulation among the agricultural section of the community is one of the world's great curses. In China, India, and Japan, and to a less degree in such regions as Germany and France, it has arisen from the gradual growth of population without any corresponding increase in the area of cultivable land. When people see large areas of uncultivated land they are inclined to think that the farmers might cultivate far more than they do, and thus might maintain a much higher standard of living. As a matter of fact, most of the uncultivated land in practically all parts of the world is in one way or another of poorer quality than that which is now cultivated. It can indeed be used for crops, but unfavorable conditions of slope, soil, drainage, climate, or location in respect to markets cause the return from a given amount of labor to be less than from the land now in use. In other words, if people cultivate this extra land they have to lower their standards of living. This is eminently the situation in Russia. Although most people do not recognize it, that country is badly overpopulated according to the standards of living prevailing in the United States or western Europe.

2. LOW PRODUCTIVITY. One reason for the overpopulation of Russia is that the average acreage of crops is only about 10 acres for each man on the farm in contrast to 14 in Germany, 34 in the United States as a whole, and 70 in Iowa. In former times the shortness of the planting season and the primitive nature of the agricultural implements made it impossible to cultivate more than this. In modern times the lack of new land fit to be cultivated has a similar limiting effect. In addition to this the yield per acre is low, averaging 700 pounds of grain per acre for all cereal crops against 1,150 in the United States as a whole, 1,690 in Iowa, and 1,730 in Germany. Moreover, Russia raises only a relatively small acreage of crops that bring a high return per acre, such as potatoes, flax, cotton, vegetables, and fruits. Making allowances for these differences, and reckoning that a pound or bushel of each crop has the same value in all countries, we find that the average production per man on the farms shows approximately the following ratios: Russia 1, Mississippi 4, Germany 5½, the United States 7½, and Iowa 15.

If machinery is introduced into a country such as Russia, it permits more land to be cultivated. Unless expensive methods of cultivation are employed, however, the yield per acre on the new land averages less than on the land already cultivated. The reason why such land has remained uncultivated is generally that it is so cold, so dry, so swampy, has such poor soil, or is otherwise so poor that it could not be made to pay under old methods. The amount of new but relatively poor land that can thus be brought into cultivation in Russia is almost certainly less than 50 per cent as extensive as the land already in cultivation. Let us suppose, however, that this amount can be cultivated. Let us also make the highly improbable supposition that all the land, old and new, is so well cultivated that it yields twice as much per acre as formerly. Even then the return per man among the farm population would still be only 40 per cent as great as among the average farmers of the United States.

The poverty of Russia cannot be remedied by taking people off the farms and setting them to work in factories. Even if industry should continue to expand, it could not absorb more than the normal increase in population due to the high birthrate. The births exceed the deaths by about 3 million people per year. Thus, even under the most favorable conditions, the 75 per cent of the people of the Soviet Republic who live on farms are not likely for many decades to attain a standard of productivity more than one-third that of the average American farmer. This explains why we say that overpopulation is one of Russia's greatest handicaps. We have dwelt on this because the same line of reasoning applies to China, India, Japan, Rumania, Yugoslavia, and even to Italy and Central Europe in a less acute form.

3. LACK OF WORK. Another great handicap of Russia is lack of work for the agricultural population. Bear in mind that practically all of Russia, aside from a small Asiatic section where most of the people are not Russians, lies farther north than any part of the United States. Moreover, the climate is everywhere continental instead of being moderated by the sea, as in Denmark. Hence the winters are very long and cold. Near Moscow, for example, the ground is frozen solid for about five months, and is extremely soft and muddy for another month when the frost leaves it. Consequently for nearly six months the men on the farms have little or no work. They own few animals, and the women do most of the work of caring for them. Only a little firewood is cut. This is partly because in cold weather all the people usually crowd into a single room, and partly because in the main agricultural regions wood is not abundant although there are huge supplies farther north. Accordingly, through no fault of their own, a large proportion of the men among the 75 per cent of the Russians who live on the farms spend five or six months each winter in doing little except sleep, eat, and talk. Of course they are soft and inefficient when the spring work begins; and then they have to work to the limit. This softness is doubtless one reason why the average amount of cultivated land per man amounts to only 9 or 10 acres in contrast to 70 in Iowa. Even when the American farmers had tools no better than those of Russia, they cultivated 20 or 30 acres per man.

The habit of idleness in winter and the weariness due to hard work in the spring tend to deaden the activity of the Russian peasants in other ways as well as in farm work. Many people believe that this is one of the main reasons why both the old Russian Empire and the new Soviet regime have been able to dominate the peasants so easily. It helps to account for the way in which the Russian troops went to pieces not only in Finland in the winter of 1939-40, but also in the first World War. This does not mean that Russia has no energetic people, for she has a great many. Their work is evident in the way in which those of the western and central parts of the old empire pushed their way across the plains into Siberia. Nor does it mean that the evils resulting from overpopulation and from lack of work during so large a fraction of the year cannot be overcome. But it does mean that, in its attempts to expand and grow great and to hold its own with the other great nations, Russia meets geographical handicaps very different from those of Germany, and greater than those of either Great Britain or the United States.

Russian Expansion. In spite of the handicaps described above, Russia is a conspicuous example of a great power which has expanded vigorously. The efficiency and activity of its people are greatest in the west. Before the first World War it was widely recognized that the Finns, the people

of the Baltic States, the Poles, and the Ukrainians were especially vigorous and progressive sections of the composite peoples comprising the old Russian Empire. In an earlier adolescent period, centuries ago, the real Russians, whose center is Moscow, pushed outward in all directions. On the west they brought all the non-Russian people who have just been named under their sway. They were checked only when they came up against highly efficient people such as the Swedes, and the Germans and Austrians who insisted on getting their share of Poland. On the east the Russians spread across Asia almost as easily as the Americans spread across the United States. Nothing checked them until they met the efficient Japanese, another nation living in one of the world's good cyclonic regions.

After the first World War there were scores of different racial and national groups within the territory of the old Russian Empire, but only the vigorous western fringe broke away. That fringe established a string of five new states from Finland to Poland. In the second World War these states were the ones that Russia tried to get back. Only the most vigorous and efficient of these—plucky little Finland—checked Russia when that power tried once more to get back to the seacoast. Although Russia was victorious because of its vast size, it proved to be no more efficient than would be expected from its continental location, low productivity, and long periods of idleness, as well as its lack of effective leaders. Finland, on the contrary, in spite of small size and scanty resources, displayed the efficiency which is characteristic of people living in the cyclonic regions. This conflict between the "Eurasian" type as represented by Russia, and the "European" type as represented by Finland, is symbolic of many of the world's political relationships. It involves the twofold problem of efficient versus inefficient people, and of one power possessing something—in this case seaports—which another power covets. It also illustrates the dominant fact of human geography—the fact that the quality of the people of a country is even more important than the natural resources. Although the quality of the people is influenced by their biological inheritance and their training, it is also largely molded by the influence of the relief, soil, waters, minerals, and climate upon man's occupations, mode of life, diet, diseases, health, and general efficiency.

QUESTIONS, EXERCISES, AND PROBLEMS

1. Make a map to show the former colonial empires of Spain and Portugal. Write notes on the climate, position, and products of the main parts. Compare the actual degree of self-government and civil liberty in these regions at present with those in the British dominions of Canada and Australia. What has this to do with the geographic environment? What effect has it on international relationships?

2. Make a tracing of the Rhine showing (*a*) the Dutch part at the mouth and one port; (*b*) the boundaries of Alsace and Lorraine; (*c*) the Valley of the Ruhr and three towns; (*d*) the Vosges Mountains and the Black Forest. Define the boundaries of Belgium and Luxembourg. Discuss the part played in both World Wars by the geographic conditions thus shown.

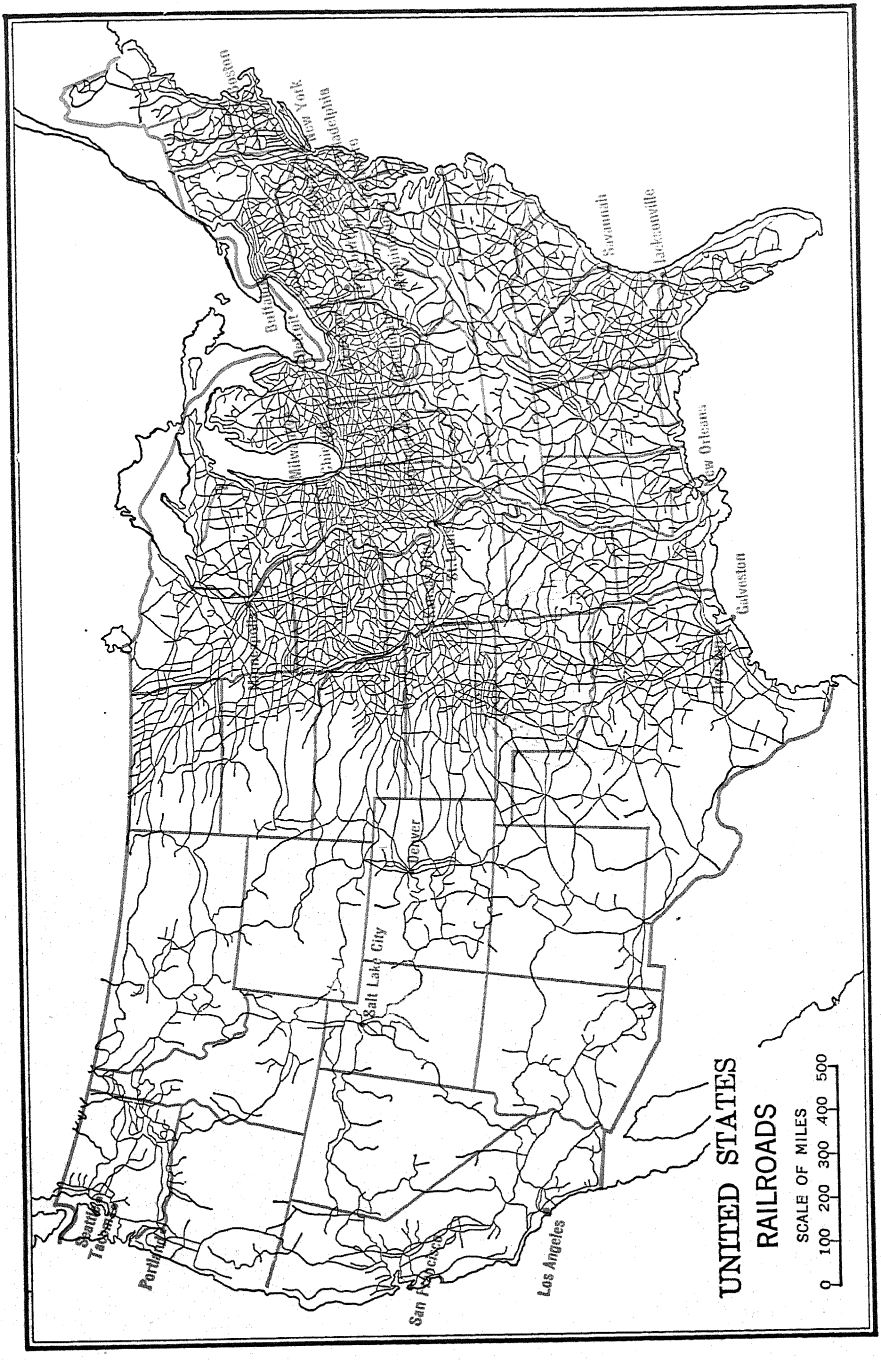
3. On an outline map of the United States apply different kinds of shading to each of the following areas: (*a*) the Atlantic coastal plain; (*b*) the Great Lakes region; (*c*) the Mississippi Valley; (*d*) the Pacific coastal regions. Discuss an international problem in which each of these is particularly interested. Show how their interest depends on geographical environment.

4. Make maps showing (*a*) French expansion into Africa; (*b*) Italian expansion into Africa; (*c*) all the spheres of influence of the United States near the Panama Zone. Point out the resemblances and differences in the expansion of these three countries, and explain them so far as they are geographical.

5. Make maps showing (*a*) the main trade routes of Europe before the discovery of America; (*b*) the main routes after the discovery of America and before the Suez Canal was dug; (*c*) the routes of the present day.

In the light of the maps comment on the commercial advantages of (*a*) England; (*b*) Germany; (*c*) Italy, in these three periods.

6. Why is the United States in closer touch with Western Europe than with China and Japan? What strictly geographical factors play a part in this?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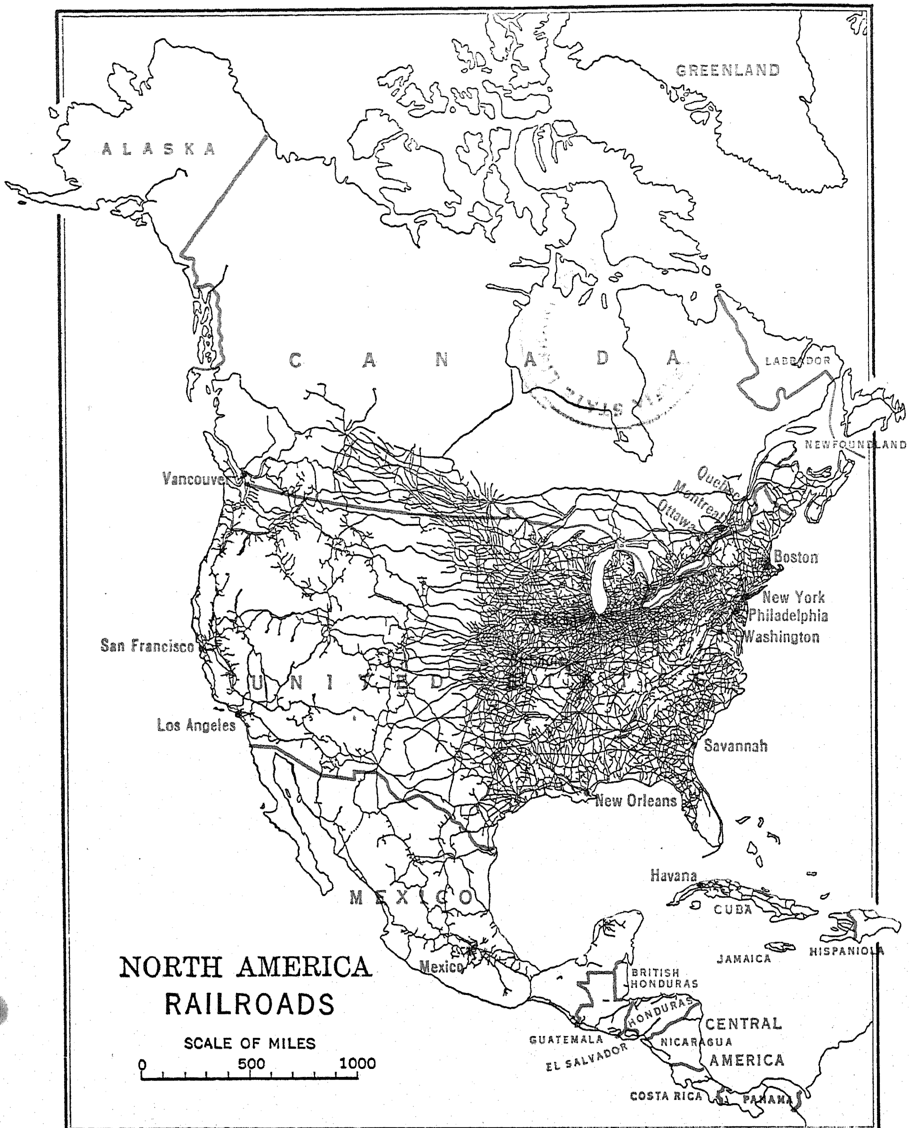

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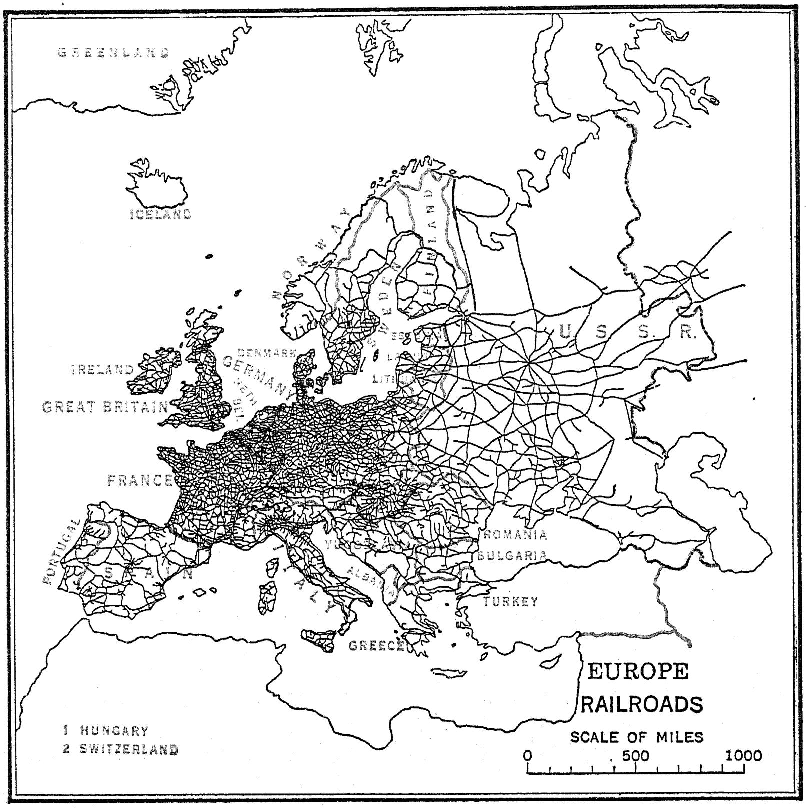
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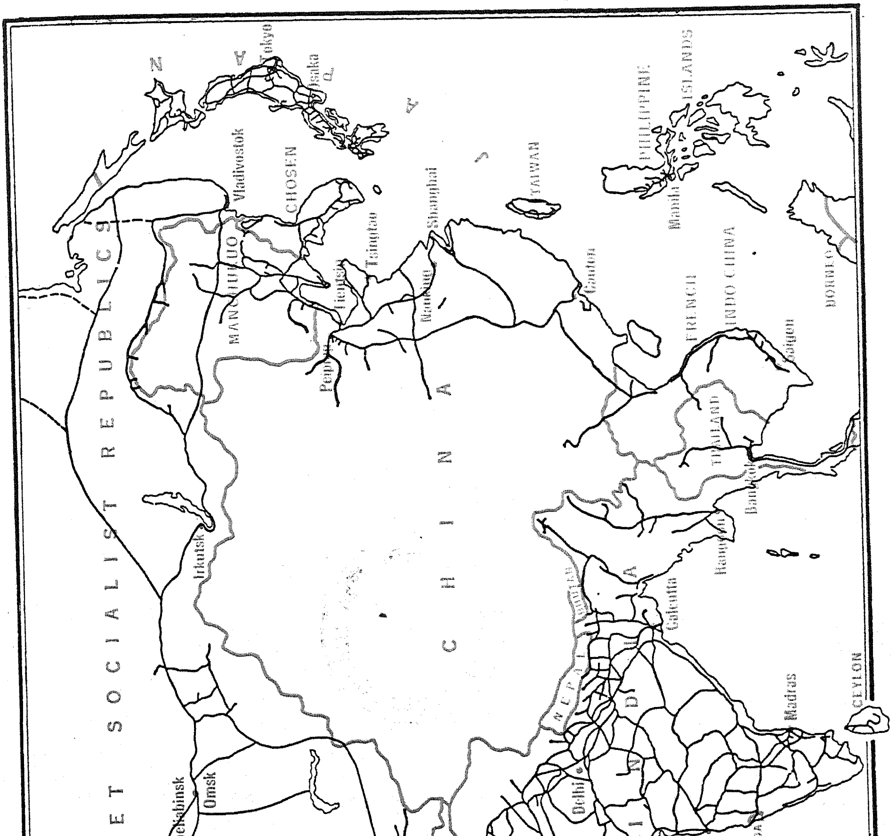
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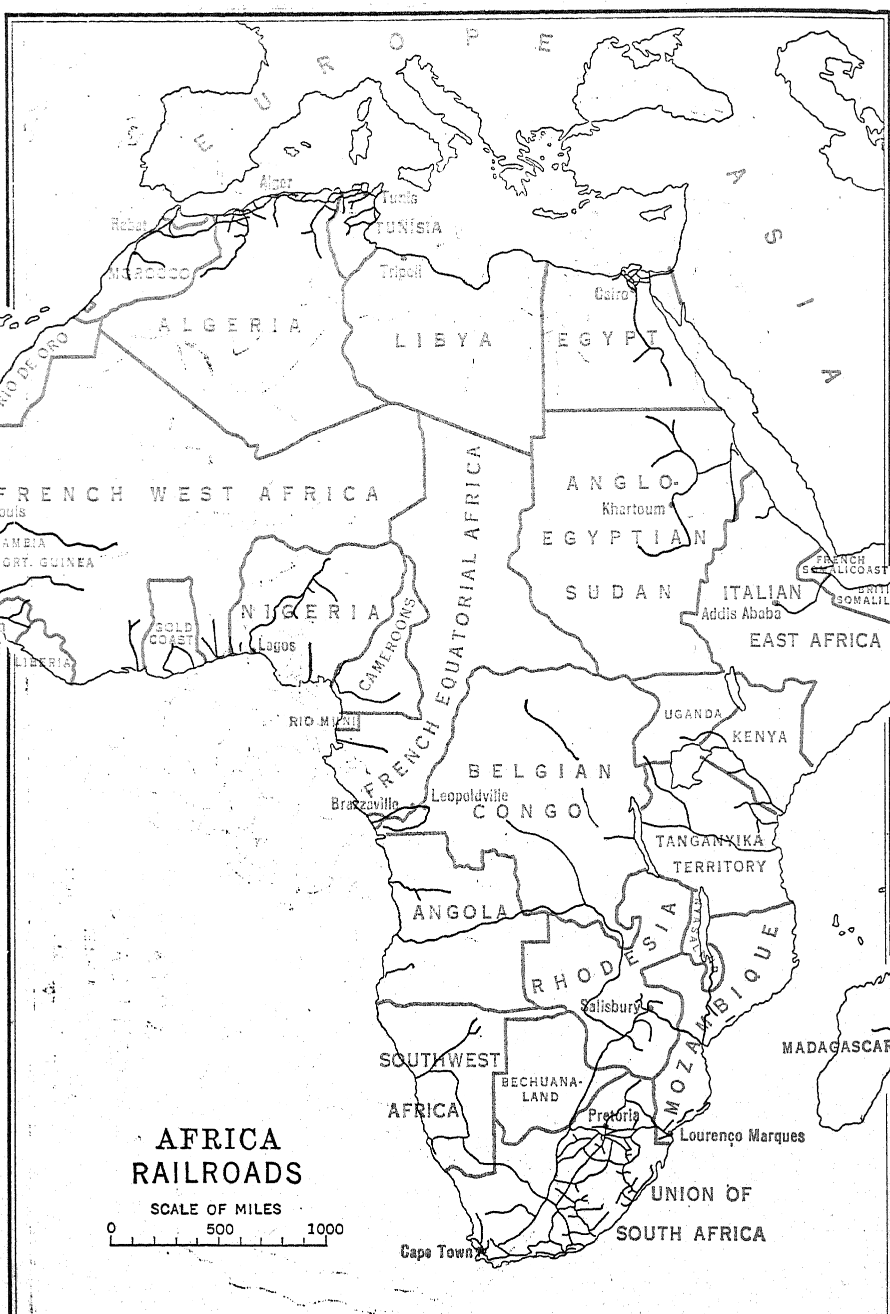
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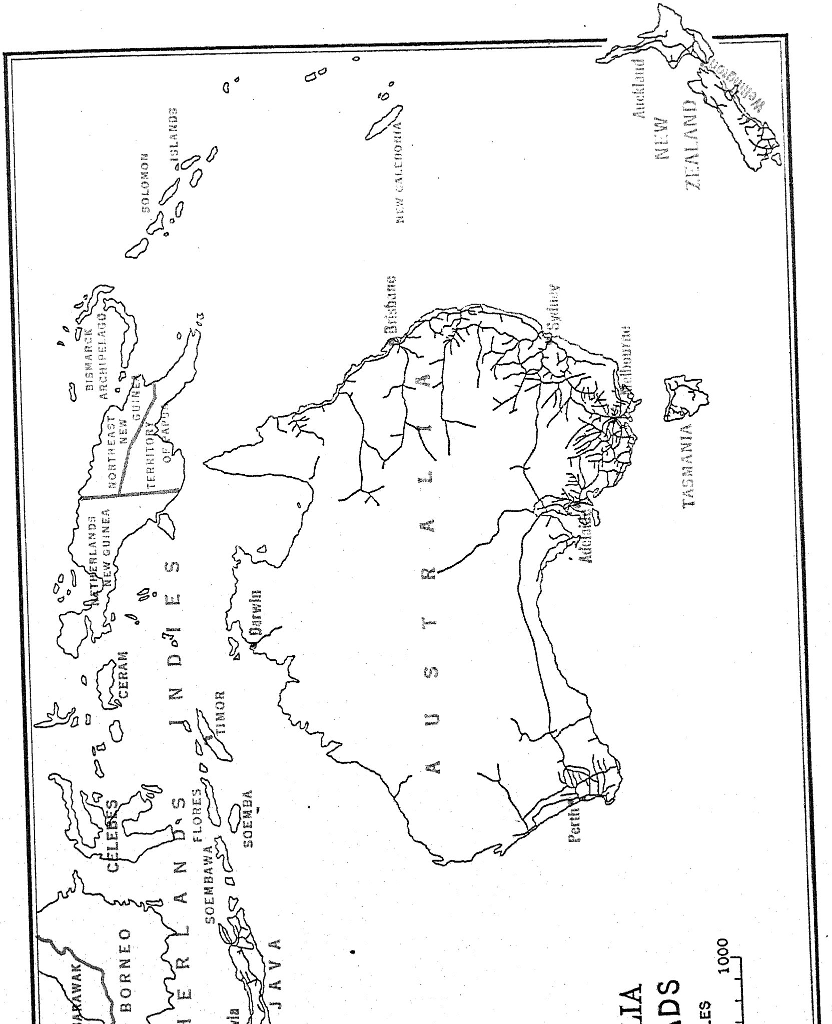
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PREFACE TO FIFTH EDITION

THE purpose of this book, as stated in the Preface to the First Edition, is "to set forth the great principles of geography in its human aspects; to provide a comprehensive, but easily taught textbook for students who have reached an age when they begin to think for themselves; and to furnish to normal-school students and to teachers in elementary schools a book which will give them a solid grounding in the human relationships which they are eager to teach. Many books have been written on anthropogeography, but there seems to be great need of a book which sums up the present status of that subject and at the same time translates it into the simpler terminology of human geography.

"The method of the book is to take up first the physical background, not dwelling on it technically, but merely sketching the main outlines, and providing an adequate basis if the teacher wishes to go farther. In case of such relatively simple matters as water bodies, little or no physiographic treatment is deemed necessary, for such details as the difference between a meandering and braided river have little effect on man's activities. The fundamental principles of climate, on the other hand, have been quite fully treated because of their supreme importance in determining man's mode of life. Nevertheless, pure meteorology receives less attention than in most of the physiographic textbooks which are now the main reliance in teaching advanced geography.

"After the physical background has been sketched each chapter or part of the book plunges directly into the main theme, that is, the relation of the physiographic environment to man's activities. This is the part of geography which is most interesting, most practical, and most calculated to call forth genuine thought and concentrated effort on the part of the student. It is also the part which in most books is more or less incidental or secondary, whereas it is here the primary object."

The chief points in which the First Edition of this book differed from other advanced textbooks of geography were its concentration on human relationships; its emphasis on the *effects* of climate rather than upon the physical and meteorological sides of the subject; its insistence on the importance of vegetation and diet; and its interpretation of political geography. This last part of the subject does not mean the study of political divisions, but of the political relationships, both domestic and foreign, which arise out of geographic conditions.

In the present (fifth) edition these original qualities remain unchanged, except that diet is discussed in many places instead of in a separate chapter. In this edition, however, more changes have been made than in any other. Approximately half of the material is new, and many minor changes have been made in the remainder. The chief new points are as follows:

(1) The chapter entitled "The Continents and Man" has been replaced by three chapters on continents and countries. These important chapters are designed to overcome the difficulty experienced by most students because they have forgotten a large part of the geography which they learned in the elementary schools. They need to become familiar once more with the location, relief, and cities of the various countries, but they ought to do this in a mature way quite different from the memory work of earlier years. Hence in these chapters all the countries of each continent are briefly discussed so that the student refreshes his memory of the basic facts of geographic location and structure. At the same time he is made to feel that the geographic facts do not occur haphazardly, but follow definite laws. Such a preview enables him to approach the rest of the book with a much better preparation than is otherwise possible.

(2) To assist in this locational study a series of railroad maps with political boundaries and names in red has been inserted at the back of the book. It is essential that these maps be carefully studied.

(3) The two chapters on political geography at the end of the Fourth Edition have been enlarged to three in this Fifth Edition. This reflects the growing realization that boundaries, minerals, other resources, trade routes, colonies, and the general diversity of opportunities and productivity among the nations are among the chief factors which control political relationships.

(4) One of the least-understood phases of geography is the diversity of the lands in low latitudes. In order to bring this out more clearly the tropical parts of the earth are discussed in two chapters devoted respectively to the poorer and the better types. A plate (Plate II at the end of the book) has been added showing the major natural regions of the entire earth. The tropical regions, as well as others, are discussed according to its divisions.

(5) Another innovation is that a discussion of local geography, or of "microgeography," has been introduced at the end of those chapters which seem to warrant it. Suggestions are given as to ways in which the students can investigate their surroundings.

(6) The problems connected with such conditions as droughts, floods, insect pests, hurricanes, soil erosion, and the control of rivers have become

so important in late years that the chapter "Geographic Variables" has been expanded and divided into two parts.

(7) Practically all the photographs in this edition are new, and many new diagrams and maps have been included.

(8) Maps are so important that methods of map-making have been placed in a separate chapter.

(9) The questions, exercises, and problems at the end of the chapters have been reduced in number and complexity.

In preparing the three new chapters on countries the author has had the helpful advice of Professors Robert M. Brown of the Rhode Island College of Education, Earl B. Shaw of the Massachusetts State Teachers College at Worcester, Massachusetts, and George F. Howe of the Teachers College of Connecticut at New Britain. In the final chapter of the book the concept of stages of development set forth by S. van Valkenburg in his *Political Geography* has been most helpful. To all of these men I am most grateful.

E. H.

July, 1940.

NOTE: For a list of illustrations and tables see the Index under the headings: *Diagrams, Maps,* and *Tables.*

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NOTE TO FOURTH EDITION

At the urgent request of many teachers a fourth edition of this book is now issued. This time the changes are so extensive that scarcely a single page is the same as in previous editions, and the whole work has been reset in fresh type. Only a few of the more notable changes can be mentioned.

In Chapter II, on *The Earth's Form and Motions,* methods of map-making receive a new treatment. In Chapter III on *The Continents,* an entirely new approach is employed, and much space is devoted to a review of the physical features of the earth as a whole. In Chapter IV on *Human Activities in Mountains and Plains,* the importance of *slopes* as an element of relief receives more prominence than formerly. Chapter VII on *Soil and the Farmer* contains not only many small additions, but also a long new section bringing out the most recent conclusions as to the relation between soils and climate. Chapters X, XI, and XII dealing with the principles of climate have also been much modified so as to make them easier to understand and at the same time more comprehensive. In the next and longest section of the book, Part VII, dealing with *Man's Regional Relationships,* the chapter on *Diet* has been omitted, and new material has been added in order to give a fuller picture of the earth's natural regions. And finally, in the last chapter, a rather full discussion of the geographic significance of Russia has been added. Many new maps are included, and many of the old ones have been revised. A new series of very complete railroad maps of the six continents deserves special mention. It supplies good material for a large number of diverse exercises which any teacher can devise to suit his own needs. A new and more convenient system of referring to illustrations by page numbers has been adopted, and all the statistical data have been brought up to date.

Many teachers and others have made suggestions which have been incorporated in this new edition, and to all of them much gratitude is due. Special thanks are due to Dr. S. Van Valkenburg and Dr. S. C. Gilfillan. The latter went over the third edition with a fine-toothed comb, making suggestions for improvements on almost every page.

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NOTE TO THIRD EDITION

THE changes in the third edition have consisted of two chief kinds: (1) Many paragraphs have been rewritten in order to bring them up to date and to take advantage of advances in geographical knowledge. (2) New maps have been substituted for those formerly used, especially in the case of those showing the distribution of minerals.

One of the important features of the present edition is a new Table of the World's Chief Products, pages 331–332, with percentages of production in cyclonic regions (p. 380 in Fourth Edition).

In preparing this new edition, I am especially indebted to Professor Stephen S. Visher of Indiana University, and to Professor S. Colomb Gilfillan, of Grinnell College.